LEWIS ANGELL, M. INST. C. E.



*From a Photograph by* F. W. CLARK.

# PROCEEDINGS

OF THE

# INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

VOLUME XVII.—1890-91.

EDITED BY

THOMAS COLE,

ASSOC. M. INST. C.E.

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*The Association is not as a body responsible for the facts and opinions advanced herein.*

E. & F. N. SPON, 125, STRAND, LONDON.

NEW YORK: 12 CORTLANDT STREET.

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Institution of municipal & county engineers, Lond.

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| Rush, J. .. .. .. .. .. | Borough Surveyor, Eye, Suffolk. |

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| York, E. A. .. .. .. .. | Surveyor to the Local Board, Tettenhall, Wolverhampton. |

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| Young, W. | Town Hall, Salford. |

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| | |
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| Aberdeenshire | J. D. Watson. |
| Abergavenny | Jon. Haigh. |
| Abingdon | G. Winship. |
| Abram | Geo. Heaton. |
| Accrington | W. J. Newton. |
| Acton | D. J. Ebbetts. |
| Allerton | A. O. Fraser. |
| Alnwick | G. Wilson. |
| Altrincham | J. Stokoe. |
| Alverstoke | W. H. Fry. |
| Antrim (County) | J. H. Brett. |
| Armagh (County) | R. H. Dorman. |
| Ashby-de-la-Zouche (R.S.A.) | J. W. Metcalf. |
| Ashford | J. Willson. |
| Ashton-under-Lyne | J. T. Earnshaw. |
| Aspull | Geo. Heaton. |
| Aston Manor | W. A. Davies. |
| Atherstone (Rural) | W. R. H. Chipperfield |
| Audenshaw | J. H. Burton. |
| Aylesbury | G. Cannon. |
| | |
| Bacup | J. Wilson. |
| Barking | C. J. Dawson. |
| Barton-upon-Irwell (Rural) | C. C. Hooley. |
| Basford Union (R.S.A.) | J. Parker. |
| Batley | J. W. Horsfield. |
| Battersea | J. T. Pilditch. |
| Bedford | J. Lund. |
| " (County) | W. H. Leete. |
| Bedlington | C. A. Copland. |
| Belfast | J. C. Bretland. |
| Belgrave | R. J. Stephens. |
| Berwick-on-Tweed | D. M. MacGregor. |
| Bethnal Green | F. W. Barratt. |
| Billesden (R.S.A.) | W. F. Ault. |
| Bingley | R. Armistead. |
| Birkenhead | T. C. Thorburn. |
| Birmingham | W. S. Till. |
| " | E. Pritchard. |
| Bishop's Stortford | R. S. Scott. |
| " " (R.S.A.) | E. T. Watts. |
| Blaby (R.S.A.) | W. H. Simpson. |
| Blackburn | J. B. McCallum |
| Blaina | G. Stevens. |
| Bolton | W. H. Brockbank. |
| " | J. Proctor. |
| Bootle-cum-Linacre | W. N. Blair. |
| Bournemouth | F. W. Lacey |
| Bowdon | J. Newton. |
| Bradford | J. H. Cox. |

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|---|---|
| Braintree .. .. .. .. .. .. | J. Mortimer. |
| Brecknock .. .. .. .. .. .. | R. Davies. |
| Brentford .. .. .. .. .. .. | J. H. Strachan. |
| Bridlington .. .. .. .. .. | R. R. Brown. |
| " .. .. .. .. .. | S. Dyer. |
| Brierfield .. .. .. .. .. .. | J. T. Landless. |
| Brierley Hill .. .. .. .. .. | J. W. Beckley. |
| Brighton .. .. .. .. .. .. | F. J. C. May. |
| " .. .. .. .. .. .. | P. C. Lockwood. |
| Brisbane, Queensland .. .. .. | T. Kirk. |
| Bristol .. .. .. .. .. .. | F. Ashmead. |
| Bromley .. .. .. .. .. .. | H. S. Cregeen. |
| Brownhills .. .. .. .. .. | J. H. Shaw. |
| Burnley .. .. .. .. .. .. | F. S. Button. |
| Burslem .. .. .. .. .. .. | F. Bettany. |
| Burton-upon-Trent .. .. .. .. | J. E. Swindlehurst. |
| Bury .. .. .. .. .. .. .. | J. Cartwright. |
| | |
| Canterbury .. .. .. .. .. | F. Baker. |
| Cardiff (Rural) .. .. .. .. | W. Fraser. |
| Carlisle .. .. .. .. .. .. | W. H. Smith. |
| Carshalton .. .. .. .. .. | T. L. Heward. |
| Cavan (County) .. .. .. .. .. | R. N. Somerville, B.E. |
| Cheadle .. .. .. .. .. .. | E. Sykes. |
| Chelmsford .. .. .. .. .. | C. Law-Green. |
| " (R.S.A.) .. .. .. .. .. | A. F. Ginn. |
| Cheltenham .. .. .. .. .. | Jos. Hall. |
| " .. .. .. .. .. .. | G. W. Sadler. |
| Cheshunt .. .. .. .. .. .. | T. Bennett. |
| Chester .. .. .. .. .. .. | I. M. Jones. |
| Chesterton .. .. .. .. .. | D. Bland. |
| Chichester .. .. .. .. .. .. | H. W. Stringfellow. |
| Clapham, S.W. .. .. .. .. .. | A. Southam. |
| Clare (County) .. .. .. .. .. | J. Hill |
| Cleator Moor .. .. .. .. .. | F. J. Edge. |
| Cockermouth .. .. .. .. .. | R. S. Marsh. |
| " (R.S.A.) .. .. .. .. | J. B. Wilson. |
| Colchester .. .. .. .. .. .. | H. Goodyear. |
| Colne .. .. .. .. .. .. .. | J. Mallinson. |
| Compton Gifford .. .. .. .. | J. C. Inglis. |
| Congleton .. .. .. .. .. .. | R. Burslam. |
| Cork (County) .. .. .. .. .. | N. Jackson. |
| Coventry .. .. .. .. .. .. | E. J. Purnell. |
| Crewe .. .. .. .. .. .. .. | G. Eaton-Shore. |
| Croydon .. .. .. .. .. .. | T. Walker. |
| " (Rural) .. .. .. .. | R. M. Chart. |
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| Darwen .. .. .. .. .. .. | W. Stubbs. |
| Dewsbury .. .. .. .. .. .. | H. C. Marks. |
| Doncaster .. .. .. .. .. .. | W. H. R Crabtree. |
| " (Rural) .. .. .. .. | C. C. Barras. |
| Dorchester .. .. .. .. .. | F T. Maltby. |
| Dorking .. .. .. .. .. .. | G. S. Mathews. |
| " (R.S.A.) .. .. .. .. .. | W. Rapley, jun. |
| Douglass .. .. .. .. .. .. | T. J. Taylor. |
| Dover .. .. .. .. .. .. .. | W. Thomas. |
| Droitwitch .. .. .. .. .. | B. Godfrey. |
| Dublin .. .. .. .. .. .. | C. Harty. |
| Dublin (County) .. .. .. .. | R. A. Gray. |
| Dudley .. .. .. .. .. .. | J. Gammage. |
| Dukinfield .. .. .. .. .. | H. Veevers. |

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| EALING | C. Jones. |
| EAST HAM | W. H. Savage. |
| EAST STONEHOUSE | J. C. Hodge. |
| EBBW VALE | T. J. Thomas. |
| EDINBURGH | J. Cooper. |
| EDMONTON | G. E. Eachus. |
| ELY | W. McKelvie. |
| EPSOM | J. R. Harding. |
| ERITH | S. Towlson. |
| ESSEX (County) | F. Whitmore. |
| ESTON DISTRICT | T. W. Stainthorpe. |
| EYE | J. Rush. |
| | |
| FAILSWORTH | C. J. Lomax. |
| FAREHAM | W. Butler. |
| FELIXTOWE | G. S. Horton. |
| FINCHLEY | F. Smythe. |
| FLEETWOOD | M. S. Gaulter. |
| FRODSHAM | W. Diggle. |
| FROME | P. Edinger. |
| „ (Rural) | A. Greenwell. |
| FULHAM | J. P. Norrington. |
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| GAINSBOROUGH | D. G. Macdonald. |
| GARSTON | H. T. Wakelam. |
| GATESHEAD-ON-TYNE | J. Bower. |
| GLOUCESTER | R. Read. |
| „ (County) | R. Phillips. |
| GRANTHAM, LINCOLNSHIRE | S. G. Gamble. |
| GREAT CROSBY | W. Hall. |
| GREAT GRIMSBY | J. Buchan. |
| GREAT YARMOUTH | J. W. Cockrill. |
| GREENOCK | A. J. Turnbull. |
| | |
| HALIFAX | E. R. S. Escott. |
| HAMMERSMITH | H. Mair. |
| HAMPSTEAD | C. H. Lowe. |
| HAMPTON | J. Kemp. |
| HANLEY | J. Lobley. |
| HANWELL | E. J. W. Herbert. |
| HARBORNE | R. Dixon. |
| HARROW | E. R. Capon. |
| HARTLEPOOL | H. C. Crummack. |
| HARWICH | H. Ditcham. |
| HASTINGS | P. H. Palmer. |
| HECKMONDWIKE | T. Gledhill. |
| HENDON | S. S. Grimley. |
| „ (Rural) | C. A. Woodbridge. |
| HENLEY-ON-THAMES | R. Pratt. |
| HEREFORD | J. Parker. |
| HERTFORD | T. R. Dickinson. |
| HESTON AND ISLEWORTH | W. B. Bromley. |
| HEXHAM | R. Grieves. |
| HEYWOOD | J. Diggle. |
| HINCKLEY | W. W. Cooper. |
| HORNSEA | P. Gaskell. |
| HORNSEY | T. De C. Meade. |
| HOUGHTON-LE-SPRING | T. Foster. |
| HOUNSLOW | W. B. Bromley. |
| HOVE | H. H. Scott. |
| HULL | A. E. White. |

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| Huntingdon .. .. .. .. .. | R. Hutchinson. |
| Hyde .. .. .. .. .. .. .. | J. Mitchell. |
| Ilkeston .. .. .. .. .. .. | H. J. Kilford. |
| Ipswich .. .. .. .. .. .. | E. Buckham. |
| Isle of Ely (County) .. .. | G. J. Moore. |
| Jarrow .. .. .. .. .. .. | J. Petree. |
| Kearsley .. .. .. .. .. .. | T. Nuttall. |
| Keighley .. .. .. .. .. .. | W. H. Hopkinson. |
| Kensington .. .. .. .. .. | W. Weaver. |
| Kent (County) .. .. .. .. .. | F. W. Ruck. |
| Kettering .. .. .. .. .. .. | W. Fairley. |
| Kidderminster .. .. .. .. .. | A. Comber. |
| King's Lynn .. .. .. .. .. | E. J. Silcock. |
| King's Norton (Rural) .. .. .. | R. Godfrey. |
| Kingston (Highway Board) .. .. | A. J. Henderson. |
| " (Rural) .. .. .. .. | W. H. Hope. |
| Kirkleatham .. .. .. .. .. | J. Howcroft. |
| Lancaster .. .. .. .. .. .. | J Cook. |
| Leamington Spa .. .. .. .. | W. De Normanville. |
| Leeds .. .. .. .. .. .. .. | T. Hewson. |
| Leek .. .. .. .. .. .. .. | J. Myatt. |
| Leicester .. .. .. .. .. .. | E. G. Mawbey. |
| Lewes .. .. .. .. .. .. | A. Holt. |
| Lewisham .. .. .. .. .. .. | J. Carline. |
| Leyton, E. .. .. .. .. .. .. | W. Dawson. |
| Lichfield .. .. .. .. .. .. | C. J. Corrie. |
| Lincoln .. .. .. .. .. .. | R. A. MacBrair. |
| Liverpool .. .. .. .. .. .. | H. P. Boulnois. |
| " .. .. .. .. .. .. .. | G. Biddle. |
| Llandaff .. .. .. .. .. .. | Jas. Holden. |
| London (County) .. .. .. .. | A. R. Binnie. |
| Londonderry, Ireland .. .. .. | W. J. Robinson. |
| Longton .. .. .. .. .. .. | J. W. Wardle. |
| Loughborough .. .. .. .. .. | Geo. Hodson. |
| Louth, Lincoln .. .. .. .. .. | T. W. Wallis. |
| Louth (County) .. .. .. .. | P. J. Lynam. |
| Lowestoft .. .. .. .. .. .. | G. H. Hamby. |
| Macclesfield (Rural) .. .. .. | J. Thorpe. |
| Maidstone .. .. .. .. .. .. | W. G. Scoones. |
| " (Rural) .. .. .. .. | S. Stallard. |
| Maldon (Rural) .. .. .. .. | A. Stewart. |
| Manchester .. .. .. .. .. | J. Newton. |
| Mansfield .. .. .. .. .. .. | R. F. Vallance. |
| Margam .. .. .. .. .. .. | W. Thomas. |
| Market Bosworth (R.S.A.) .. .. | H. W. Taylor. |
| Market Harboro' .. .. .. .. | H. G. Coales. |
| Melton Mowbray .. .. .. .. | E. Jeeves. |
| Mexborough .. .. .. .. .. | T. Humphries. |
| Middlesbrough .. .. .. .. .. | E. D. Latham. |
| Middleton, Lancashire .. .. .. | W. Welburn. |
| Millom .. .. .. .. .. .. | H. Waye. |
| Milton-next-Sittingbourne .. .. | A. B. Acworth. |
| Milverton .. .. .. .. .. .. | G. F. Smith. |
| Mirfield .. .. .. .. .. .. | F. H. Hare. |
| Monmouthshire (County) .. .. | W. Tanner. |
| Montreal, Canada .. .. .. .. | P. St. George. |
| Mortlake .. .. .. .. .. .. | H. Richards. |

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| NEATH (R.S.A.) | W. E. C. Thomas. |
| NELSON-IN-MARSDEN | J. A. Crowther. |
| " | W. Dent. |
| NEW BARNET | G. W. Brumell. |
| NEWBURY | E. A. Stickland. |
| NEWCASTLE-ON-TYNE | W. G. Laws. |
| " | J. P. Spencer. |
| NEWCASTLE-UNDER-LYME | J. Pattison, jun. |
| NEW MALDEN | T. L. Heward. |
| NEWPORT, SALOP | G. B. Hammonds. |
| NEWTON ABBOTT | L. Stevens. |
| NEWTON-IN-MAKERFIELD | R. Brierley. |
| NORTH BIERLEY | P. Ross. |
| NORTH MAYO (County) | W. P. Orchard. |
| NORWICH | P. P. Marshall. |
| NOTTINGHAM | A. Brown. |
| " (County) | E. P. Hooley. |
| NUNEATON | J. S. Pickering. |
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| OKEHAMPTON | H. Geen. |
| OLDBURY | H. Richardson. |
| ORRELL | G. Heaton. |
| OUNDLE | J. M. Siddons. |
| OXFORD | W. H. White. |
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| PADDINGTON | Geo. Weston. |
| PADIHAM | J. Gregson. |
| PAIGNTON | W. J. Wyatt. |
| PEEBLES | R. S. Anderson. |
| PEMBERTON | Geo. Heaton. |
| PENMAENMAUR | J. C. Coverley. |
| PETERBOROUGH | J. W. Walshaw. |
| PLUMSTEAD | W. G. Forder. |
| PLYMOUTH | G. D. Bellamy. |
| POOLE | J. Elford. |
| PONTYPOOL | D. H. W. Powell. |
| POPLAR | G. F. Holt. |
| PORTLAND | J. L. Webster. |
| PORTSMOUTH | P. Murch. |
| PRESCOT | W. Goldsworth. |
| PUTNEY | J. C. Radford. |
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| RAMSBOTTOM | T. Nuttall. |
| RAMSGATE | W. A. M. Valon. |
| READING | A. E. Collins. |
| " | A. W. Parry. |
| REDDITCH | S. E. Thorrold. |
| RHYL | Robt. Hughes. |
| RICHMOND | W. Brooke. |
| ROCHDALE | S. S. Platt. |
| ROCHESTER | W. Banks. |
| ROTHERHAM | G. Jennings. |
| ROWLEY REGIS | W. H. Brettell. |
| RUGBY | J. H. Brierley. |
| RYDE | F. Newman. |
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| SALE | A. G. McBeath. |
| SELBY | T. Mallinson. |
| SEVENOAKS | J. Mann. |

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| Shanghai, China .. .. .. .. | C. Mayne. |
| Sheffield .. .. .. .. .. .. .. | C. F. Wike. |
| " .. .. .. .. .. .. .. | R. Davidson. |
| Sherborne .. .. .. .. .. .. .. | T. Farrall. |
| Shifnal .. .. .. .. .. .. .. | W. F. T. Molineux. |
| Shirley and Freemantle .. .. | H. J. Weston. |
| Shildon .. .. .. .. .. .. .. | W. A. Mason. |
| Shrewsbury .. .. .. .. .. .. | W. C. Eddowes. |
| Shropshire (County) .. .. .. | A. T. Davis. |
| Sleaford .. .. .. .. .. .. .. | Jesse Clare. |
| Smethwick .. .. .. .. .. .. .. | J. C. Stuart. |
| Solihull (R.S.A.) .. .. .. .. | A. E. Currall. |
| Somerton .. .. .. .. .. .. .. | I. T. Hawkins. |
| Southampton .. .. .. .. .. .. | W. B. G. Bennett. |
| " .. .. .. .. .. .. | J. Lemon. |
| South Brisbane .. .. .. .. | T. C. Deverell. |
| Southend-on-Sea .. .. .. .. | P. Dodd. |
| Southgate .. .. .. .. .. .. .. | C. G. Lawson. |
| South Hornsey .. .. .. .. | M. W. Jameson. |
| Southport .. .. .. .. .. .. .. | W. Crabtree. |
| South Shields .. .. .. .. .. .. | M. Hall. |
| Stafford .. .. .. .. .. .. .. | W. Blackshaw. |
| Stamford .. .. .. .. .. .. .. | Jas. Richardson. |
| Stapleton .. .. .. .. .. .. .. | A. J. Saise. |
| Stockport .. .. .. .. .. .. .. | J. Atkinson. |
| Stockton .. .. .. .. .. .. .. | K. P. Campbell. |
| Stourbridge .. .. .. .. .. .. | W. Fiddian. |
| Strand .. .. .. .. .. .. .. | A. Ventris. |
| Stratford-on-Avon .. .. .. .. | T. T. Allen. |
| Streatham .. .. .. .. .. .. .. | Jas. Barber. |
| Stretford .. .. .. .. .. .. .. | H. Royle. |
| St. George the Martyr, Southwark .. .. .. .. .. .. .. | A. M. Hiscocks. |
| St. George's, Hanover Square .. | G. Livingstone. |
| St. Giles .. .. .. .. .. .. .. | G. Wallace. |
| St. Helen's .. .. .. .. .. .. | G. J. C. Broom. |
| St. Luke, Middlesex .. .. .. | M. C. Meaby. |
| St. Martin-in-the-Fields .. .. | C. Mason. |
| St. Mary, Islington .. .. .. | J. P. Barber. |
| St. Mary, Newington .. .. .. | J. Gledhill. |
| St. Saviour, Southwark .. .. | G. R. Norrish. |
| St. Thomas, near Exeter .. .. | S. Churchward. |
| Sunderland .. .. .. .. .. .. | R. S. Rounthwaite. |
| Sussex (E.) (County) .. .. .. | Hy. Card. |
| Sutton Coldfield .. .. .. .. .. | C. F. Marston. |
| Sutton, Surrey .. .. .. .. .. | E. W. Crickmay. |
| Sutton-in-Ashfield .. .. .. .. | McW. Bishop. |
| Swansea (Rural) .. .. .. .. | J. Thomas. |
| Tamworth (R.S.A.) .. .. .. | H. J. Clarson. |
| Tendring (R.S.A.) .. .. .. .. | G. H. Sasse. |
| Tettenhall .. .. .. .. .. .. | E. A. Yorke. |
| Tewkesbury, Gloucestershire .. | W. H. Gray. |
| Tipton .. .. .. .. .. .. .. | W. H. Jukes. |
| Todmorden .. .. .. .. .. .. | H. Shaw. |
| " .. .. .. .. .. .. .. | A. Greenwood. |
| Tooting .. .. .. .. .. .. .. | Jas. Barber. |
| Toowong, Queensland .. .. .. | W. E. Irving. |
| Torquay .. .. .. .. .. .. .. | H. A. Garrett. |
| Tottenham .. .. .. .. .. .. | J. E. Worth. |
| Toxteth Park .. .. .. .. .. .. | J. Price. |

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| Tunstall .. .. .. .. .. .. | A. R. Wood. |
| Turton .. .. .. .. .. .. | Jas. Parkinson. |
| | |
| Ventnor .. .. .. .. .. .. | E. J. Harvey. |
| " .. .. .. .. .. .. | J. G. Livesay. |
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| Wakefield .. .. .. . .. .. | R. Porter. |
| " (Rural) .. .. .. .. | F. Massie. |
| Wallasey .. .. .. .. .. .. | A. Salmon. |
| Walsall .. .. .. .. .. .. | R. H. Middleton. |
| Walton-on-the-Hill .. .. .. | S. Middlebrook. |
| Wanstead .. .. .. .. .. .. | J. T. Bressey. |
| Wantage .. .. .. .. .. .. | W. Hanson. |
| Warwickshire .. .. .. .. .. | J. Willmot. |
| Waterloo, Liverpool .. .. .. | R. Thompson. |
| Watford .. .. .. .. .. .. | D. Waterhouse. |
| " (Rural) .. .. .. .. | G. A. Heath. |
| Wavertree .. .. .. .. .. .. | I. Dixon. |
| Wallsend .. .. .. .. .. .. | G. Hollings. |
| Wellingborough .. .. .. .. | E. Sharman. |
| West Bromwich, Staffordshire .. | J. T. Eayrs. |
| West Cowes .. .. .. .. .. | N. F. Dennis. |
| West Ham, London .. .. .. | L. Angell. |
| West Hartlepool .. .. .. .. | J. W. Brown. |
| Westminster .. .. .. .. .. | G. R. W. Wheeler. |
| Weymouth and Melcombe Regis .. | W. B. Morgan. |
| Whitehaven .. .. .. .. .. | J. S. Brodie. |
| " .. .. .. .. .. | R. Pickering. |
| Widnes .. .. .. .. .. .. | J. S. Sinclair. |
| " .. .. .. .. .. .. | T. Higginson. |
| Willesden .. .. .. .. .. .. | O. C. Robson. |
| Wimbledon .. .. .. .. .. | C. H. Cooper. |
| Wirksworth .. .. .. .. .. | J. Simpson. |
| Withington .. .. .. .. .. | A. H. Mountain. |
| Wolverhampton .. .. .. .. | R. E. W. Berrington. |
| Woodford .. .. .. .. .. .. | J. D. Hooper. |
| Wood Green .. .. .. .. .. | C. J. Gunyon. |
| " .. .. .. .. .. | C. L. Walker. |
| Worksop .. .. .. .. .. .. | O. E. Harrison. |
| Worthing .. .. .. .. .. .. | M. Aspinall. |
| Wrexham .. .. .. .. .. .. | J. W. M. Smith. |
| " .. .. .. .. .. .. | A. S. Jones. |
| " (Rural) .. .. .. .. | A. C. Baugh. |
| Wuerdle and Wardle .. .. .. | G. H. Wild. |
| | |
| York .. .. .. .. .. .. .. | A. Creer. |
| " (Rural) .. .. .. .. .. | W. G. Penty. |

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## PARLIAMENTARY COMMITTEE.

O. C. Robson, *Chairman*.

Lewis Angell (West Ham).
G. E. Eachus (Edmonton).
E. B. Ellice-Clark (Westminster).

Chas. Jones (Ealing).
T. De C. Meade (Hornsey).
T. Walker (Croydon).

# Memorandum of Association

OF

# THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

1. The name of the Association is "The Incorporated Association of Municipal and County Engineers."

2. The Registered Office of the Association will be situated in England.

3. The objects for which the Association is established are :—

(*a*) The promotion of the science and practice of engineering applied to the health and improvement of counties and towns, and rural districts.

(*b*) The promotion of the professional interests, rights, powers, and privileges of county, urban, and rural engineers, the improvement of their professional status, and the extension and interchange of professional knowledge and practice.

(*c*) The acceptance of any gift, endowment, or bequest, made to the Association, and the carrying out of any trusts attached to any such gift, endowment, or bequest.

(*d*) The examination of persons in engineering, surveying, building construction, sanitary science and works, and in local government, municipal and sanitary law; and the granting of certificates of having passed the examination in the above subjects to candidates. Provided that no such certificate be granted without a note on it stating that "This Certificate shows the result of an Examination held on behalf of the Association, and is not to be deemed a qualification to discharge the duties of any office or appointment."

(e) The constitution of two classes of members, viz.:—Members and Graduates; and, when thought proper, the election of persons distinguished in connection with Municipal Engineering or in Sanitary Science, as Honorary Members.

(f) Subject to the provisions of the 21st section of The Companies Act of 1862, the acquisition and disposal of lands and property for the objects aforesaid.

(g) The doing all such lawful things as are incidental or conducive to the attainment of the above objects.

4. The income and property of the Association, whencesoever derived, shall be applied solely towards the promotion of the objects of the Association as set forth in this Memorandum of Association; and no portion thereof shall be paid or transferred, directly or indirectly, by way of dividend, bonus, or otherwise howsoever, by way of profit to the Members of the Association. Provided that nothing herein shall prevent the payment in good faith, of remuneration to any officers or servants of the Association, or to any Member of the Association, or other person, in return for any services actually rendered to the Association.

5. The fourth paragraph of this Memorandum is a condition on which a Licence is granted by the Board of Trade to the Association, in pursuance of section 23 of the Companies Act, 1867.

6. If any Member of the Association pays or receives any dividend, bonus, or other profit, in contravention of the terms of the fourth paragraph of this Memorandum, his liability shall be unlimited.

7. Every Member of the Association undertakes to contribute to the Assets of the Association, in the event of the same being wound up during the time that he is a Member, or within one year afterwards, for payment of the debts and liabilities of the Association contracted before the time at which he ceases to be a Member, and of the costs, charges, and expenses of winding up the same, and for the adjustment of the rights of the contributories amongst themselves, such amount as may be required, not exceeding one pound, or in case of his liability becoming unlimited, such other amount as may be required in pursuance of the last preceding paragraph of this Memorandum.

8. If upon the winding up or dissolution of the Association there remains, after the satisfaction of all its debts and liabilities, any property whatsoever, the same shall not be paid to or distributed among the Members of the Association, but shall be given or

transferred to some other institution or institutions having objects similar to the objects of the Association, to be determined by the Members of the Association at or before the time of dissolution, or in default thereof by such Judge of the High Court of Justice as may have or acquire jurisdiction in the matter.

9. True accounts shall be kept of the sums of money received and expended by the Association and the matter in respect of which such receipt and expenditure takes place, and of the property, credits, and liabilities of the Association; and, subject to any reasonable restrictions as to the time and manner of inspecting the same that may be imposed in accordance with the regulations of the Association for the time being, shall be open to the inspection of the Members. Once at least in every year the accounts of the Association shall be examined, and the correctness of the Balance Sheet ascertained, by one or more properly qualified Auditor or Auditors.

We, the several persons whose names are subscribed, are desirous of being formed into an Association in pursuance of this Memorandum of Association.

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Names, Addresses, and Descriptions of Subscribers.

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H. Percy Boulnois, M. Inst. C.E., City Engineer, Liverpool.
E. Pritchard, M. Inst. C.E., Birmingham.
E. R. S. Escott, M. Inst. C.E., Borough Surveyor, Halifax.
T. De Courcy Meade, A. M. Inst. C.E., Surveyor to the Local Board, Hornsey.
W. Santo Crimp, A. M. Inst. C.E., District Engineer, London County Council.
A. W. Parry, A. M. Inst. C.E., Borough Surveyor, Reading.
T. Walker, A. M. Inst. C.E., Borough Surveyor, Croydon.

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Dated the 13th day of September, 1890.

Witness to the above signatures,

Thomas Cole, A.M. Inst. C.E.
*Secretary.*

11, Victoria Street,
London, S.W.

# Articles of Association

OF

# THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

## Introduction.

**WHEREAS** an Association, called "the Association of Municipal and Sanitary Engineers and Surveyors" (hereinafter referred to as the "existing Association"), has long existed for objects similar in many respects to the objects expressed in the Memorandum of the Association to which these Articles apply (hereinafter called "the Association"), and the existing Association consists of Members, Graduates, and Honorary Members, and is possessed of Books, Drawings, and Property used for the objects aforesaid;

**AND WHEREAS** the Association is formed for furthering and extending the objects of the existing Association, by a registered Association, under the Companies Acts 1862 to 1866; and terms used in these Articles are intended to have the same respective meanings as they have when used in those Acts, and words implying the singular number are intended to include the plural number and vice versâ;

Now therefore it is hereby agreed as follows:—

## Constitution.

1. For the purpose of registration, the number of Members of the Association is declared to be five hundred. But the Council may at any time register an increase of Members as occasion shall require.

### Members.

2. The Subscribers of the Memorandum of Association, and such other persons as shall be admitted in accordance with these Articles, and none others, shall be Members of the Association, and be entered on the Register as such.

3. Any person may become a Member of the Association who, being a Member of the existing Association, shall agree to transfer his Membership of the existing Association, and all rights and obligations incidental thereto, to the Association, and to be registered as a Member of the Association accordingly.

4. Any person may become a Member of the Association who shall be qualified and elected, as hereinafter mentioned, and shall agree to become such Member, and shall pay the entrance fee and first subscription accordingly.

5. The rights and privileges of every Member of the Association shall be personal to himself, and shall not be transferable or transmissible by his own act or by operation of law.

### Qualification and Election of Members.

6. The qualification of Members shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

7. The election of Members shall be conducted as prescribed by the Bye-laws from time to time in force, as provided by the Articles.

### Graduates and Honorary Members.

8. Any person may become an Honorary Member or Graduate of the Association who, being already an Honorary Member or Graduate of the existing Association, shall agree to transfer his interest in the existing Association, and all rights and obligations incidental thereto, to the Association.

9. The Association may admit such other persons as may be hereafter qualified and elected in that behalf as Graduates and Honorary Members respectively of the Association, and may confer upon them such privileges as shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles: Provided that no Graduate or Honorary Member shall be deemed to be a Member within the meaning of the Articles.

10. The qualification and mode of election of Graduates and Honorary Members shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

## Entrance Fees and Subscriptions.

1. The Entrance Fees and Subscriptions of Members and Graduates shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles; and the form of request for admission to Membership shall contain a reference to such Subscriptions. Provided that no Entrance Fee shall be payable by a Member or Graduate of the existing Association.

## Expulsion.

12. If any Member or Graduate shall leave his subscription in arrear for two years, and shall fail to pay such arrears within three months after a written application has been sent to him by the Secretary, his name may be struck off the List of Members or Graduates, as the case may be, by the Council at any time afterwards, and he shall thereupon cease to have any rights as a Member or Graduate, but he shall nevertheless continue liable to pay the arrears of subscription due at the time of his name being so struck off:

Provided always that this regulation shall not be construed to compel the Council to remove any name if they shall be satisfied the same may be retained.

13. The Council may refuse to continue to receive the subscriptions of any person who shall have wilfully acted in contravention of the lawful regulations of the Association, or who shall in the opinion of the Council have been guilty of such conduct as shall have rendered him unfit to continue to belong to the Association, and may remove his name from the List of Members, Graduates, or Honorary Members (as the case may be), and such person shall thereupon cease to be a Member or Graduate (as the case may be) of the Association. Provided that notice shall be given to the offending Member, and opportunity of explanation given to him, before his name is removed from the List of Members.

### General Meetings.

14. The first General Meeting shall be held on such day within four months of the Registration of the Association as the Council shall determine. Subsequent Meetings shall consist of the Annual General Meeting and Special Meetings as hereinafter defined.

15. The Annual General Meeting shall take place in June or July of every year, at such place as the Council shall determine.

16. A Special Meeting may be convened at any time by the Council, and shall be convened by the Secretary whenever a requisition signed by twenty Members of the Association, specifying the object of the Meeting, is left with the Secretary.

If for fourteen days after the delivery of such requisition a Meeting be not convened in accordance therewith, the Requisitionists or any twenty Members of the Association may convene a Special Meeting in accordance with the requisition. All Special Meetings shall, unless otherwise determined by the Council, be held in London.

17. At least seven clear days' notice of every Meeting, specifying generally the nature of any special business to be transacted at any Meeting, shall be given to every Member of the Association, and no other special business shall be transacted at such Meeting; but the non-receipt of such notice shall not invalidate the proceedings of such Meeting. No notice of the business to be transacted (other than such Ballot Lists as may be requisite in case of Elections) shall be required in the absence of special business.

18. Special business shall include all business for transaction at a Special Meeting, and all business for transaction at every other Meeting, with the exception of the reading and confirmation of the Minutes of the previous Meeting, the Election of Members and Graduates, and the reading and discussion of communications as prescribed by the Bye-laws, or any regulations of the Council made in accordance with the Bye-laws.

### Proceedings at General Meetings.

19. Thirty Members shall constitute a Quorum for the purpose of a Meeting of the Association.

20. If within thirty minutes after the time fixed for holding

the Meeting, a Quorum is not present, no Meeting shall be held, and all matters which might, if a Quorum had been present, have been done at a Meeting (other than a Special Meeting) so dissolved, may forthwith be done on behalf of the Meeting by the Council.

21. The President shall be Chairman at every Meeting, and in his absence one of the Vice-Presidents; and in the absence of all Vice-Presidents a Past President or a Member of Council shall take the Chair; and if no Past President or Member of Council be present and willing to take the Chair, the Meeting shall elect a Chairman.

22. The decision of a Meeting shall be ascertained by show of hands, unless, after the show of hands, a poll is forthwith demanded, and by a poll when a poll is thus demanded. The manner of taking a show of hands or a poll shall be in the discretion of the Chairman, and an entry in the Minutes, signed by the Chairman, shall be sufficient evidence of the decision of the Meeting. Each Member shall have one vote and no more. In case of equality of votes the Chairman shall have a second or casting vote, provided that this Article shall not interfere with the provisions of the Bye-laws as to election by ballot.

23. The acceptance or rejection of votes by the Chairman shall be conclusive for the purpose of the decision of the matter in respect of which the votes are tendered, provided that the Chairman may review his decision at the same Meeting if any error be then pointed out to him.

## Bye-Laws.

24. The Bye-laws set forth in the Schedule to these Articles, and such altered and additional Bye-laws as shall be added or substituted as hereinafter mentioned, shall regulate all matters by the Articles left to be prescribed by the Bye-laws, and all matters which, consistently with the Articles, shall be made the subject of Bye-laws. Alterations in, and additions to, the Bye-laws, may be made only by resolution of the Members at an Annual General Meeting, and after notice of motion for such purpose, and the general tenor of the proposed resolution thereon, has been sent to the Secretary on or before the 31st of March preceding the date of the Annual General Meeting, and such notice of motion and

resolution shall be printed in the Agenda for the ensuing Annual General Meeting. Provided that no regulation shall be made or altered by a Bye-law which, if any, could only be legally imposed by Article of Association, or added or altered by a Special Resolution.

## Council.

25. The affairs of the Association shall be governed by a Council who shall be chosen from the Members only, and shall consist of one President, three Vice-Presidents, twelve Ordinary Members of Council, Honorary Secretary, and Honorary Treasurer, and of the Past Presidents and District Honorary Secretaries for the time being; and the first Council (which shall include Past Presidents of the existing Association) shall be as follows:—

### President.

H. P. Boulnois, M. Inst. C.E., Liverpool.

### Past Presidents.

| | |
|---|---|
| Lewis Angell, M. Inst. C.E. .. .. | West Ham. |
| James Lemon, M. Inst. C.E. .. .. | Southampton. |
| F. Ashmead, M. Inst. C.E. .. .. | Bristol. |
| G. F. Deacon, M. Inst. C.E. .. .. | Liverpool. |
| E. Pritchard, M. Inst. C.E. .. .. | Birmingham and London. |
| W. S. Till, M. Inst. C.E. .. .. .. | Birmingham. |
| C. Jones, Assoc. M. Inst. C.E. .. .. | Ealing, W. |
| W. H. White, M. Inst. C.E. .. .. | Oxford. |
| W. G. Laws, M. Inst. C.E. .. .. | Newcastle. |
| J. Lobley, M. Inst. C.E. .. .. .. | Hanley. |
| E. B. Ellice-Clark, M. Inst. C.E. .. | West Sussex. |

### Vice-Presidents.

| | |
|---|---|
| C. Dunscombe, M.A., M. Inst. C.E. .. | Liverpool. |
| T. Hewson, M. Inst. C.E. .. .. .. | Leeds. |
| T. De C. Meade, Assoc. M. Inst. C.E. | Hornsey. |

### Ordinary Members of Council.

| | |
|---|---|
| W. B. G. Bennett, Assoc. M. Inst. C.E. | Southampton. |
| A. Brown, M. Inst. C.E. .. .. .. | Nottingham. |
| J. Cartwright, M. Inst. C.E. .. .. | Bury. |

| | |
|---|---|
| J. H. Cox, Assoc. M. Inst. C.E. .. | Bradford. |
| W. S. Crimp, Assoc. M. Inst. C.E. .. | Wimbledon. |
| J. T. Eayrs, Assoc. M. Inst. C.E. .. | West Bromwich. |
| E. R. S. Escott, M. Inst. C.E. .. .. | Halifax. |
| A. M. Fowler, M. Inst. C.E. .. .. | Stockport. |
| J. B. McCallum, M. Inst. C.E. .. | Blackburn. |
| H. U. McKie, M. Inst. C.E. .. .. | Carlisle. |
| A. W. Parry, Assoc. M. Inst. C.E. .. | Reading. |
| T. Walker, M. Inst. C.E. .. .. .. | Croydon |

District Honorary Secretaries.

*Home Counties District.*—O. C. Robson, Assoc. M. Inst. C.E., Willesden.
*Midland Counties District.*—A. T. Davis, Assoc. M. Inst. C.E., Shrewsbury.
*Yorkshire District.*—E. G. Mawbey, Assoc. M. Inst. C.E., Leicester.
*Lancashire and Cheshire District.*—S. S. Platt, Assoc. M. Inst. C.E., Rochdale.
*Western District.*—Joseph Hall, Assoc. M. Inst. C.E., Torquay.
*Northern District.*—T. Dawson, Benwell.
*Eastern Counties District.*—E. Buckham, M. Inst. C.E., Ipswich.
*Wales.*—J. W. M. Smith, Wrexham.

Honorary Secretary.

C. Jones, Assoc. M. Inst. C.E., Ealing, W.

Honorary Treasurer.

Lewis Angell, M. Inst. C.E., West Ham.

26. The first Council shall continue in office till the Annual General Meeting in the year 1891. The President, Vice-Presidents, and Ordinary Members of the Council (other than Past Presidents) shall retire at each succeeding Annual General Meeting, but shall be eligible for re-election.

27. The election of a President, Vice-President, and Members of the Council, shall be conducted in such manner as shall be prescribed by the Bye-laws from time to time in force.

28. The Council may supply any casual vacancy in the Council (including any casual vacancy in the office of President) which shall occur between one Annual General Meeting and another, and the President or Members of the Council so appointed by the Council shall retire at the succeeding Annual General Meeting. Vacancies not filled up at any such Meeting shall be deemed to be casual vacancies within the meaning of this Article.

### Officers.

29. The Secretary, Officers, and Servants of the Association shall be appointed and removed in the manner prescribed by the Bye-laws from time to time in force, as provided by the Articles. Subject to the express provisions of the Bye-laws, the Secretary, Officers, and Servants of the Association shall be appointed and removed by the Council.

30. The powers and duties of the Secretary and Officers of the Association shall (subject to any express provision in the Bye-laws) be determined by the Council.

### Powers and Procedure of Council.

31. The Council may regulate their own procedure, and delegate any of their powers and discretion to any one or more of their body, and may determine their own quorum. If no other number is prescribed, three Members of Council shall form a quorum.

32. The property of the existing Association shall be acquired by the Association, and the Council shall manage and administer the property, proceedings, and affairs of the Association, in accordance with the Bye-laws from time to time in force.

33. The Council may from time to time invest, in the name of the Association, any moneys not immediately required for the purposes of the Association, in Stocks, Funds, or Securities in which Trustees are by law for the time being authorised to invest.

34. No act done by the Council, which shall receive the express or implied sanction of the Members of the Association in General Meeting, shall be afterwards impeached by any Member of the Association on any ground whatsoever, but shall be deemed to be an act of the Association.

### District Committees.

35. District Committees of the Association may be formed, and District Secretaries appointed, in accordance with the Bye-laws for the time being of the Association, and there shall be referred to such Committees all such local or other business and matters as the Bye-laws for the time being shall prescribe, or as may be specially referred to them or any of them by the Council; but the Acts and Resolutions of the District Committees shall not be binding upon the Association unless approved of by the Council. Ten members shall constitute a Quorum of a District Committee.

## Examinations.

36. The Council may hold Examinations of persons in Engineering, Surveying, Building Construction, Sanitary Science and Works, and in Local Government, Municipal and Sanitary Law, in accordance with the Bye-laws for the time being of the Association, and they may grant Certificates of competency in the above subjects to Candidates.

## Notices.

37. A notice may be served by the Council of the Association upon any Member, Graduate, or Honorary Member, either personally or by sending it through the post in a prepaid letter addressed to such Member, Graduate, or Honorary Member, at his registered place of abode.

38. Any notice, if served by post, shall be deemed to have been served at the time when the letter containing the same would be delivered in the ordinary course of the post, and in proving such service it shall be sufficient to prove that the letter containing the notice was properly addressed, and put into the post office.

39. No Member, Graduate, or Honorary Member, not having a registered address within the United Kingdom, shall be entitled to any notice; and all proceedings may be had and taken without notice to such Member, in the same manner as if he had had due notice.

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Names, Addresses, and Descriptions of Subscribers.

H. Percy Boulnois, M. Inst. C.E., City Engineer, Liverpool.
E. Pritchard, M. Inst. C.E., Birmingham.
E. R. S. Escott, M. Inst. C.E., Borough Surveyor, Halifax.
T. De Courcy Meade, A. M. Inst. C.E., Surveyor to the Local Board, Hornsey.
W. Santo Crimp, A. M. Inst. C.E., District Engineer, London County Council.
A. W. Parry, A. M. Inst. C.E., Borough Surveyor, Reading.
T. Walker, M. Inst. C.E., Borough Surveyor, Croydon.

---

Dated the 13th day of September, 1890.

Witness to the above signatures,

Thomas Cole, A.M. Inst. C.E.,
*Secretary.*

11, Victoria Street,
London, S.W.

# SCHEDULE.

## BYE-LAWS.

### Membership.

1. Members, Graduates, and Honorary Members of the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates, or Honorary Members respectively of the Association, without election or payment of entrance fees.

### Members.

2. Candidates for admission as Members must be Civil Engineers or Surveyors holding chief permanent appointments under any Municipal Corporations, County Councils, or Urban or Rural Sanitary Authorities, and Civil Engineers or Surveyors holding other chief permanent appointments under any Public Authority of the like nature within the United Kingdom, or in the Colonies or foreign countries.

### Graduates.

3. Candidates for admission as Graduates must be successful in obtaining certificates of competency at any examination under the auspices of the Association, and who are not otherwise qualified as Members of the Association; and as such shall be entitled to attend the General and District Meetings, and to take part in the proceedings thereof, and be entitled to a copy of the Minutes of Proceedings, but shall not be entitled to vote. Graduates shall at their request become Members of the Association when qualified according to Bye-law 2.

### Honorary Members.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

5. The Members, Graduates, and Honorary Members shall have notice of and the privilege to attend all Meetings, and be entitled to a copy of the Proceedings of the Association as published.

## Entrance Fees and Subscriptions.

6. An Entrance Fee of One Guinea shall be paid by each Member, except Members of the existing Association, who shall pay no Entrance Fee. Each Member shall pay an Annual Subscription of One Guinea.

7. A Graduate shall not be required to pay an Entrance Fee, either on his becoming a Graduate or on his becoming a Member. Each Graduate shall pay an Annual Subscription of Half a Guinea.

8. All Subscriptions shall be payable in advance, and shall become due on the 1st day of May in each year; and Members elected between the 1st day of January and the 1st day of May in each year, are required to pay an Entrance Fee on Election, their first Subscription being due on the 1st day of May following their Election.

9. The Council may at their discretion reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Proceedings or Ballot Lists shall be sent to Members or Graduates who are in arrear with their Subscriptions more than twelve months, and whose Subscriptions shall not have been remitted by the Council as hereinbefore provided.

## Election of Members and Graduates.

11. A recommendation for admission according to Form A for a Member, and Form B for a Graduate, in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next Meeting of the Council.

The recommendation must be signed by not less than Two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside England and Wales not known by two Members of this Association, may be proposed by three Corporate Members of the Institution of Civil Engineers. Members who cease to hold their appointments are eligible for re-election by the Council, but will be disqualified from holding any Office.

All Elections of Members and Graduates of the Association shall

be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-Laws.

13. A qualified Graduate desirous of becoming a Member shall forward to the Secretary a recommendation according to Form D in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E. A Graduate on becoming qualified to be a Member shall cease to be a Graduate.

### Election of President, Vice-Presidents, and Members of Council.

14. The Council shall nominate one name for President, six for Vice-Presidents, one for Honorary Secretary, and fifteen for Ordinary Members of Council. In addition to these each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the last named nominations exceeding fifteen, the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Members' nominations must be in the hands of the Secretary on or before the 20th of April in each year. And in case the Members' nominations should not reach fifteen, the Council shall have the power to make up the total number of nominations to twenty. Such list of twenty nominations shall be printed and sent to each Member of the Association not less than fourteen days previous to the Annual Meeting. Each Member shall be entitled to vote for or erase any of such Nominations or substitute other names, subject in all cases to the limits of Clause 25 in the Articles of Association, and return the same within seven days from the date of issue. Such Ballot Papers shall be examined in London by the President, Secretaries, and two Scrutineers appointed at the previous Annual Meeting, or by any two of the aforesaid Members. Any Member canvassing for votes for the office of Member of council shall be considered ineligible for Election.

## APPOINTMENT AND DUTIES OF OFFICERS.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary, if desirous of resigning his appointment, shall give the same notice. The remuneration of the Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary, under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President); to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that he may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

## EXAMINATIONS.

18. Two examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science, and the Public Health Acts, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be 12 in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the Engineering profession. Four of such Board shall be selected by the Council to carry out each Examination, who as "Acting Examiners," shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

### Miscellaneous.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the Members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at their Annual General Meeting.

# APPENDIX.

## Form A.

### THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

I hereby request to be enrolled as a Member of The Incorporated Association of Municipal and County Engineers, and, if so enrolled, I do hereby undertake to abide by the Rules of the Association, and to pay the Annual Subscription prescribed by the Bye-laws and Articles for the time being in force.

Witness my hand this__________day of__________18

*Signature*____________________

*Name in full*____________________

*Address*____________________

*Town or District represented*____________________

*Qualification, Bye-Law* 2____________________

We, the undersigned, from our personal knowledge, propose and recommend the above named____________________as possessing the qualification necessary to become a Member of the Association.

____________________ } *Signatures of at least Two Members of the Association are required for the proposal of a Member.*

____________________

## Form B.

### THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

Having passed the Examination and holding the Certificate of Competency, I hereby request to be enrolled as a Graduate of the Incorporated Association of Municipal and County Engineers, and, if so enrolled, I do hereby undertake to abide by the Rules of the Association.

Witness my hand this__________day of__________18

*Signature*______________________________

*Name in full* ______________________________

*Address in full*______________________________

*Date of Certificate*______________________________

We the undersigned, from our personal knowledge, propose and recommend the above named____________________as possessing the qualifications necessary to become a Graduate of the Association.

| | |
|---|---|
| ____________________<br>____________________ | *Signatures of at least Two Members of the Association are required for the proposal of a Graduate.* |

## Form C.

### THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

SIR,

I have to inform you that at a Council Meeting held on the __________day of__________18____you were elected a__________ of the Incorporated Association of Municipal and County Engineers.

I am, sir,

Your obedient servant,

______________________________

*Secretary.*

## Form D.

### THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

Being duly qualified according to Bye-law 2, I hereby request to be transferred from the class of Graduate to that of Member of the Incorporated Association of Municipal and County Engineers, and, if so transferred, I do hereby undertake to abide by the Rules of the Association, and to pay the Annual Subscription prescribed by the Bye-laws and Articles for the time being in force.

Witness my hand this__________day of__________18

*Signature*____________________

*Name in full*____________________

*Address*____________________

*Town or District represented*____________________

*Qualifications, Bye-law* 2____________________

We the undersigned, from our personal knowledge, propose and recommend the above named____________________as possessing the qualifications necessary to become a Member of the Association.

____________________ } *Signatures of at least Two Members of the Association are required for the proposal of a Member.*

____________________

## Form E.

### THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

SIR,

I have to inform you that at a Council Meeting held on the __________day of__________18____you were transferred from the class of Graduates to that of Members of this Association.

I am, sir,

Your obedient servant,

____________________

*Secretary.*

## Form F.

### THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

*Address* ______________________________

*Date* ______________________________

As a [*Member*, *Graduate*, or *Honorary Member*] of the Association of Municipal and Sanitary Engineers and Surveyors, I claim to become a [*Member*, *Graduate*, *or Honorary Member*] of the Incorporated Association of Municipal and County Engineers. And I hereby agree to transfer my Membership in the Association of Municipal and Sanitary Engineers and Surveyors, and all rights and obligations incidental thereto to the Incorporated Association of Municipal and County Engineers.

Please to register my name accordingly.

*Signature* ______________________________

*To*

THE SECRETARY
of the Incorporated Association of
Municipal and County Engineers.

THE

# INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

## EIGHTEENTH ANNUAL MEETING

LONDON, *June* 25*th*, 26*th*, *and* 27*th*, 1891.

### GENERAL BUSINESS.

THE Members assembled in the Theatre of the Institution of Civil Engineers, Great George Street, Westminster, when Mr. H. P. Boulnois, President, took the chair, and the Minutes of the Annual Meeting held in Liverpool in June 1890, were read, confirmed, and signed.

The SECRETARY then read the Council's Annual Report for the year ending April 30th, 1891.

### ANNUAL REPORT.

In presenting their Eighteenth Annual Report, the Council have pleasure in being able to again congratulate the members on the maintained progress of the Association during the past year.

The most important event of the year was the Incorporation of the Assocication under the Companies Act, which was effected in September last, and at the required statutory meeting, the Council presented a Report which fully set forth the causes that led to the step being taken, and the reasons for the alteration in the title. It is therefore only necessary here briefly to allude to this event, and the Council trust that the action which has been taken will serve to strengthen the position of the Association, improve its status,

and go far to induce not only all Municipal Engineers to feel the necessity of joining, but also the County Surveyors, to whom it is hoped the Association will be found of great benefit both in meetings, the discussions, and the visits to works.

Since the last Annual Meeting in Liverpool, on the 26th, 27th, and 28th of June 1890, there have been held six District Meetings, viz., at Croydon on the 19th July, 1890; at Edinburgh on the 26th and 27th September; at Cheltenham on the 9th May, 1891; at Stourbridge on the 23rd May; at Hastings on the 30th May; and at Norwich on the 13th June. Of these meetings, the visit to Edinburgh and the Forth Bridge was the first meeting that the Association has held out of England; and, encouraged by the success of that visit, the Council have notified a visit to Dublin, which, if appreciated to the same extent as the Scotch visit, will possibly tend to the institution of autumnal visits outside of England in future years.

During the financial year ending April 30th, 41 new members, consisting of 36 ordinary members and 5 graduates, have joined the Association, 20 names have been written off or their addresses become unknown, 34 members have not sent in their transfers from the old Association to the new; and the Council regret to report the deaths of Sir Joseph Bazalgette and Mr. W. Wilson, of Dalton-in-Furness.

The numbers on the roll of the Association at the close of the year were—13 honorary members, 364 ordinary members, and 26 graduates, making a total of 403 as against 419 last year. This reduction in the number is due to the fact that, owing to the incorporation of the Association, it was necessary for all members to re-submit their names as wishing to belong to the Incorporated Association, and in the case of the above 34 members this has not yet been done.

The Balance-sheet which accompanies this Report shows a balance in hand, on April 30th last, of 139*l.* 14*s.* 6*d.* In the liabilities appears a debt due to the solicitors, Messrs. Pritchard & Co., estimated at 60*l.*, being their account for the expenses of the incorporation of the Association. The assets compare favourably with the liabilities, and the financial position of the Association is therefore satisfactory. In accordance with the Rules, the finance statement of the year has been duly confirmed by the Auditors, who have obtained from the Bankers of the Association an acknowledgement of the securities.

The ballot lists having been duly issued, the scrutineers report the result of the voting as follows:—

President—T. De C. Meade.

Vice Presidents—J. Cartwright, T. Hewson, and T. Walker.

Ordinary Members of Council—A. R. Binnie, A. Brown, J. Cooper, J. H. Cox, J. T. Eayrs, E. R. S. Escott, S. Harty, C. H. Lowe, J. B. McCallum, S. S. Platt, O. C. Robson, and C. F. Wike.

General Honorary Secretary—C. Jones.

Treasurer—L. Angell.

Since the last report two examinations have been carried out, the first of which was held on the 3th and 4th of October last. At this examination eight candidates presented themselves, of whom six satisfied the examiners, and were granted certificates. The examiners were Messrs. Lemon, Lobley, Meade, and Crimp. The second examination was held on the 17th and 18th of April of this year, when nine candidates presented themselves, and of these eight satisfied the examiners and were granted certificates. The examiners were Messrs. Ellice-Clark, Meade, Lemon, and Santo Crimp. Both of these examinations were held in London, the first at the offices of the Association, and the second at the Institution of Civil Engineers, the use of which was kindly granted by the Council of that body.

The question of the age of candidates coming up for examination has been under the consideration of the Council, and it has been determined to fix the minimum age of candidates at 22.

The next examination will be held at the Town Hall, Manchester, on the 3rd and 4th October.

The Council having handed the mass of papers, documents, and books on the subject of Sewer Ventilation, that had been collected by Mr. Laws on behalf of the committee appointed to investigate the subject, to Mr. Gilbert Redgrave, to collate the information contained, hope to have that gentleman's report in time to publish with this year's volume of 'Proceedings.' At the same time the Council desire to express to Mr. Laws their thanks for the valuable aid he has afforded in framing the inquiry, and for the trouble he has taken in the first stage of this important work.

The Parliamentary Committee have met upon several occasions for the purpose of considering suggested amendments to the Public Health Act, 1875. Many such suggestions have been received from various members of the Association, but the subject is so important and the extent of the work so large as to render it quite impossible for the committee to present any definite report to the

meeting upon this occasion. They are however in hopes of being able to formulate the various amendments before the next Session of Parliament, when it has been kindly promised by one of the members of the House of Commons that he would be glad to receive same with a view to considering if such amendments or any portion thereof could be included in future legislation affecting Public Health.

The committee appointed to award the premiums for the two best papers read in the twelve months ending at the last annual meeting, have recommended that the first premium of 10*l.* be given to Mr. Spinks for his paper entitled "The River Mersey," read at the last annual meeting held at Liverpool, and the second premium of 5*l.* to Mr. W. Santo Crimp for his paper entitled "Wimbledon and its Public Works," read at the district meeting at that town, and the Council have awarded these prizes accordingly. The Council desire to repeat that it is hoped the granting of these premiums will tend to emulate members to come forward with first-class papers and so increase the value and the importance of the Association's 'Proceedings.'

The report was unanimously adopted.

It having been moved and seconded, it was agreed that the various District Secretaries continue in office till the next meeting in their respective districts; and on the motion of Mr. Laws, Mr. James Howcroft, of Kirkleatham, was appointed Hon. Secretary for the Northern District.

Messrs. Brooks, Eachus, Radford, and Silcock were appointed scrutineers for the ensuing year.

Messrs. R. Godfrey and S. G. Gamble were appointed auditors for the ensuing year.

The President then presented the premiums to Messrs. Spinks and Santo Crimp.

Mr. Bouluois introduced his successor, Mr. T. De C. Meade, who then took the chair.

Mr. Lemon proposed and Mr. Pritchard seconded a hearty vote of thanks to Mr. Boulnois, the retiring President, for his valuable services during his two years of office.

Mr. Boulnois having returned thanks, the President then read his inaugural address.*

CHAS. JONES, *Hon. Sec.*
THOMAS COLE, *Secretary.*

* This address, and the papers read at the Meeting, will be found at p. 168.

### RECEIPTS.

| RECEIPTS. | £ | s. | d. |
|---|---|---|---|
| To Balance at Bank, May 1st, 1890 | 54 | 19 | 5 |
| „ Entrance Fees | 36 | 15 | 0 |
| „ Subscriptions | 367 | 10 | 0 |
| „ Subscriptions paid in advance | 5 | 15 | 6 |
| „ Arrears | 69 | 6 | 0 |
| „ Publishers' sale of 'Proceedings' | 39 | 17 | 2 |
| „ Examination Fees | 54 | 12 | 0 |
| „ Sale of Pamphlet Index | 0 | 2 | 6 |
| „ Interest on Southampton Corporation Stock | 10 | 4 | 8 |
| „ Balance of Petty Cash due to Secretary | 6 | 16 | 7 |
| | £645 | 18 | 10 |

### EXPENDITURE.

| EXPENDITURE. | | £ | s. | d. |
|---|---|---|---|---|
| By Report Acton and Ealing Meeting | | 3 | 3 | 0 |
| „ „ Hereford and Haverhill Meetings | | 6 | 6 | 0 |
| „ „ Burnley Meeting | | 2 | 2 | 0 |
| „ „ Annual „ | | 10 | 0 | 0 |
| „ „ Croydon „ | | 3 | 3 | 0 |
| „ „ Edinburgh „ | | 2 | 2 | 0 |
| „ „ Statutory „ | | 1 | 1 | 0 |
| „ Expenses Annual Meeting, 1890 | | 8 | 1 | 9 |
| „ „ Edinburgh „ | | 5 | 8 | 6 |
| „ Examiners' Fees and Expenses | | 32 | 10 | 7 |
| „ Spon's account for Prizes | | 14 | 19 | 3 |
| „ Irvine's account for sundry Printing } 1st account | £31 10 8 | | | |
| } 2nd „ | 17 19 2 | 49 | 9 | 10 |
| „ Clowes (Vol. XVI. and other Printing) | 190 4 0 | | | |
| „ „ Postage of Vol. XVI. | 7 5 4 | 197 | 9 | 4 |
| „ Printing Mr. Colam's paper | | 4 | 18 | 6 |
| „ Waterlow's account, No. 1 | 1 7 6 | | | |
| „ „ „ No. 2 | 15 6 | 2 | 3 | 0 |
| „ Secretary's Salary | | 100 | 0 | 0 |
| „ Rent | | 30 | 0 | 0 |
| „ Petty Cash—Postages | 10 3 11 | | | |
| „ „ General | 22 17 6 | 33 | 1 | 5 |
| „ Bank charges | | 0 | 5 | 2 |
| „ Balance at Bank, April 30, 1891 | | 139 | 14 | 6 |
| | | £645 | 18 | 10 |

## STATEMENT OF ASSETS AND LIABILITIES, APRIL 30TH, 1891.

### LIABILITIES.

| LIABILITIES. | £ | s. | d. |
|---|---|---|---|
| To Estimated Liability on Vol. XVII. | 30 | 0 | 0 |
| „ Sundry Printing | 20 | 0 | 0 |
| „ Secretary, Balance of Petty Cash | 6 | 16 | 7 |
| „ Messrs. Pritchard & Co., estimated | 60 | 0 | 0 |
| „ Examiners' Expenses, estimated | 25 | 0 | 0 |
| „ Balance | 473 | 4 | 9 |
| | £615 | 1 | 4 |

### ASSETS.

| ASSETS. | | £ | s. | d. |
|---|---|---|---|---|
| By Balance at Bank | | 139 | 14 | 6 |
| „ £300 Southampton Corporation 3½ per cent. Stock | | 304 | 10 | 0 |
| „ Subscriptions in Arrear | 55 13 0 | | | |
| „ „ less 50 per cent. bad | 27 16 6 | 27 | 16 | 6 |
| „ Proceedings in Stock | 226 0 8 | | | |
| „ „ less 50 per cent. | 113 0 4 | 113 | 0 | 4 |
| „ Office Furniture | | 30 | 0 | 0 |
| | | £615 | 1 | 4 |

Audited and found correct, ROBT. GODFREY, } *Auditors.*
*May* 15*th*, 1891. SIDNEY G. GAMBLE, }

LEWIS ANGELL, *Treasurer.* CHAS. JONES, *Hon. Sec.*
THOMAS COLE, *Secretary.*

# DISTRICT MEETING AT CROYDON.

**July 19th, 1890.**

*Held at the South Norwood Public Baths.*

Mr. C. Jones, Past President, *in the Chair.*

Mr. O. C. Robson, of Willesden, was unanimously re-elected Honorary Secretary for the Home Counties District.

## SOME OF THE PUBLIC WORKS OF CROYDON.

By THOMAS WALKER, M. Inst. C.E., Borough and Water Engineer, Croydon.

### SOUTH NORWOOD PUBLIC BATHS.

These consist of a first class swimming bath, 65 feet by 28 feet, with 32 dressing boxes; a second class open-air swimming bath, 70 feet by 38 feet, with 54 covered dressing boxes; 9 men's private baths; 7 women's private baths; with ticket office, waiting room, and committee room; and on first floor a residence for the manager.

The water is heated in two single-flued Cornish steam boilers, 20 feet long and 5½ feet diameter.

Last year 32,200 persons used the baths. The receipts were 508*l*., and the expenditure 547*l*., in addition to the repayment of principal and interest. The quantity of water used was 10,450,000 gallons, and the cost of heating the water 114*l*., 110 tons of steam coal being used. The cost of the baths and land has been about 8,000*l*.

The swimming baths are emptied as often as necessary, sometimes four times a week, with a freshening up several times between.

Our chief public baths are at Croydon, and are on the same lines but much larger. The open-air bath at each place is the only novelty, and is generally preferred in the bathing season to the covered ones.

The prices for bathing are as follows:—

| | *d.* |
|---|---|
| First class swimming bath .. .. .. .. .. .. .. .. | 6 |
| " " " " schools and swimming clubs .. .. | 3 |
| Open-air bath .. .. .. .. .. .. .. .. .. .. .. | 2 |
| " " " Board-school children .. .. .. .. .. .. | 0½ |
| First class private bath .. .. .. .. .. .. .. .. .. | 6 |
| Second " " " .. .. .. .. .. .. .. .. .. .. | 3 |

The walls and floor of the swimming baths are concrete, made of burnt ballast and Portland cement, 6 to 1, the white tiles being bedded in neat cement. No clay puddle was used, and the work is perfectly watertight. Burnt ballast for concrete requires soaking in water for a few days before using.

Mr. W. Lambert, of South Norwood, was the architect for the baths, with the exception of the open-air bath, which was erected by the author.

## SOUTH NORWOOD IRRIGATION FARM.

The drainage area flowing to this farm is about 2,400 acres, the population upon it 15,500, and the rateable value 90,000*l.*

About two-thirds of the roads have separate drains for storm water, discharging into watercourses, which also receive rain water off the fronts of some of the houses.

The dry weather flow from the sewers averages about 500,000 gallons a day; this increases to about 3,000,000 gallons during heavy storms, the whole of which is dealt with on the farm in the best manner to cleanse it, regardless of damage to crops. Anything of the nature of a storm overflow does not exist in connection with the farm or the sewers.

Twenty-six years ago, 36 acres of this farm were first irrigated; since then two additions have been made, the last one of 40 acres about a year ago, and 44 acres more of freehold will be available in 1893. The present area is 79 acres freehold, and 32½ acres leasehold at 10*l.* 15*s.* per acre per annum; the latter includes 4 acres which cannot be irrigated.

The depth of the soil is about 10 inches, the subsoil generally is a brick clay, as will be seen by the brickfields surrounding the farm on all sides.

No trace of sewage in the subsoil will usually be found 12 inches below the surface.

A portion of the farm has shallow drains, averaging about 2 feet deep, the outflow from which passes on to land below; their use is to drain the ground quicker after the sewage is taken off the plots.

The sewage passes through two screening or settling tanks, 60 feet by 12 feet, without any addition in the shape of lime or chemicals.

The solids are lifted out of the tanks about three times in a fortnight, by dredger buckets, and flow into bins, are there covered with burnt house refuse, and then carted to low places on the farm, where it arrives within a week of its removal from the tanks. A little of it is used as manure where the land is not irrigated, and it will be available to mix with the soil, of which there is very little, on the next addition to the farm.

The annual cost of thus dealing with the solids may be put at about 110*l.*, and the quantity carted away about 1300 cubic yards.

Over 74 acres the sewage flows by gravitation, but upon 33½ acres it has to be lifted 10 feet, 14 feet, or 24 feet. This is done by a 6 H.P. cycle gas engine and bucket-and-plunger pumps. The price of gas is 2*s.* 6*d.* per 1000 cubic feet; and the cost of it for lifting 1000 gallons of sewage 100 feet high has been two-thirds of a penny, as against one-sixth of a penny for coals at Addington Well, the price of coal there being 22*s.* 9*d.* per ton.

Broad or surface irrigation only is in use, or in other words the sewage flows slowly over the surface of the land in a thin film amongst the rootlets of the rye-grass (which often lie where their food is, above the surface). These take up the impurities in the sewage, and after a flow of about 250 yards it is bright and clear. The bringing-on carriers are usually covered up pipes and the catch-up carriers open channels. The sewage is applied to about four plots in succession before it leaves the farm. From careful gaugings the effluent leaving has been found to be about 80 per cent. of the sewage coming on the farm, but this varies with the season of the year.

The small watercourse into which the effluent flows, is a branch of the Chaffinch Brook, which flows into the Ravensbourne, the latter joining the Thames at Deptford.

During the past ten years nothing but rye-grass has been grown, but now we have more land, mangold wurtzel will be grown a

little as a change crop. Unfortunately rye-grass is not in such demand in the neighbourhood as it was; more milk comes to London by rail than formerly, and the price of grass is consequently lower. Seven crops from the same plot have been cut during a season, yielding a gross return of 40*l.* an acre, but the average is five crops. They are usually very heavy ones, of a dark green colour.

As the land lately added to the farm is only getting into working order, last year's accounts are not so reliable as the present year's will be, but the receipts for crops on the present area may be put at 1250*l.*; rent and repayment of capital and interest, 2070*l.*; all other outgoings, 1,100*l.*; so that the disposal of the sewage on the farm at the present time costs 5½*d.* in the pound on the rateable value of the district flowing to the farm, and the Corporation is gradually acquiring a valuable freehold estate.

## Sewer Ventilation.

Although no sewer works are inspected, the sewer ventilators will be seen in passing up Shirley Hill Road.

In common with other towns, sewer ventilation in Croydon has passed through various phases. Up to 1876 no town used charcoal in sewer ventilators so fully. Four men were exclusively engaged in changing it and reburning it. Since then the manholes and ventilators have been open to the street surface. Complaints have been made of the smells from them, and 6-inch and 8-inch round and 8-inch by 6-inch square iron ventilation pipes have been run up trees and buildings from near the top of the manholes or from small special chambers on the sewers, generally with the best results. Where we have been unable to get pipes placed as above, a few isolated columns 25 feet long and 8 inches diameter have also been fixed.

We have allowed all comers to try anything that an inventive age could suggest, most of them not worth a moment's consideration One of Keeling's destructors has been well tried, with results far better than any other. It was placed on high ground on the apex of a 9-inch sewer, and in the 6-inch pipe connected with it an anemometor was placed for many weeks, registering the speed of air passing from the sewer to the destructor. The average was 1507 cubic feet per hour with 8 cubic feet of gas consumed in the burner, and the temperature of the air inside the column 4 inches above the burner was 190° Fahr. This was tested last April, the

destructor having all the recent patented improvements in it. At the same time I found, by placing similar anemometers in the ventilation pipes in various parts of the Borough, that the average was 1852 cubic feet per hour. The patentee expressed his satisfaction with the result of the test of the destructor, and I am sure the Association will agree with me that the average amount of sewer air passing up the ventilation pipes was eminently satisfactory.

A special anemometer has been used that does not unregister if the current is reversed. If the anemometer was reversed, it would register the down current only.

We have about 250 pipe ventilators in use, chiefly up houses, and almost every week others are put up. Where a sewer ventilator smells, or is supposed to do so, there is very little difficulty in getting permission to erect a ventilation pipe. This is done on the understanding that it is taken down in twenty-four hours if the owner or occupier requests it.

### Sewer Flushing.

This is done in a variety of ways, 40 automatic concrete tanks holding from two to three thousand gallons each are in daily use, 13 iron tipping tanks holding about 100 gallons are filled about 4 times a day. Then there are about 85 flushing stations used by coupling up a few feet of hose to valves on the water mains with the manhole or other inlet to the sewers. Two flushing vans on the average are also in use for other places where water mains are not near the sewers. A large quantity of water is thus used, which is obtained from the Corporation mains.

Taking working expenses to pump, supply, and deliver the water into account, the cost of a flush from an automatic tank is less than that of one flush from a water van.

## CROYDON WATERWORKS.

These were opened on the 2nd August, 1888, and consist of a well and pumping station, and a service reservoir on Addington Hills, with connecting pumping and service mains.

## Addington Well.

The well is situated at Hare's Bank, three-quarters of a mile south of Addington Village. The level of the ground is 318 feet above sea level.

The well is sunk to a depth of 200 feet, all in chalk, and is 10 feet in diameter. The top 75 feet is lined with 9-inch brick-work in cement. The lowest bed of flints, or bottom of the Upper Chalk, was passed at 152 feet from the surface.

Water was first found at a depth of 87 feet; the largest yield during the sinking was about 180,000 gallons a day.

Headings have been driven in several directions from the well, chiefly at 142 feet from the surface. On the east side, several important water-bearing fissures were crossed. The first of these cut through increased the pumping 600,000 gallons a day. In continuing the headings on this side, several more important fissures were cut through, yielding large supplies of water, and when the yield was 2,491,000 gallons in the twenty-four hours, the work in the well had to cease through the inability of the two 24-inch pumps to keep the water down.

The total length of the headings is 813 yards, and they are generally 6 feet high and 4½ feet wide. The storage capacity of these and the lower part of the well is about 502,000 gallons. The cost of the headings averaged 3*l.* 5*s.* 9*d.* per foot per run.

### *Pumping Machinery.*

This has been erected by Messrs. Easton and Anderson, and comprises a 125 horse-power compound beam engine of the Woolf type, three steel boilers, and double-acting pumps of the bucket-and-plunger pattern.

The engine has high-pressure cylinder, 20 inches diameter and 4 feet stroke, low-pressure cylinder, 34 inches diameter and 6 feet stroke. The capacity of the two are in the ratio of 1 to 4⅓.

The well pump is worked from the well end of the beam, and lifts the water into a tank under the engine-house floor; and the reservoir pump, by a continuation of the low-pressure piston rod, forces it from this tank into the reservoir. Both pumps are 19 inches diameter and 6 feet stroke, and deliver 72 gallons each stroke. The engine makes 18 strokes per minute, and therefore delivers 77,760 gallons per hour.

The boilers have single flues, and are 26 feet long and 5 feet in diameter; the working pressure is 100 lbs. per square inch.

The pumps are so arranged that a duplicate set can be put in the well. The buildings are large enough to contain duplicate engine and boilers. Two cottages are erected for the engine-driver and stoker.

A large copper float with wire attachment on which brass marks are placed 10 feet apart, indicates at all times, on a 10-feet gauge, the level of the water in the well above Ordnance datum.

An overhead travelling crane has been fixed for hoisting from the bottom of the well by steam, or lifting parts of the engine or pumps by hand gear.

The best large Welsh steam coal is used (Fforchaman), and last year's pumping was as follows:—221⅓ million gallons pumped to reservoir; 242 tons of coal used during the day, and 96·2 tons for banking up fires and getting up steam in the morning; average height of lift, 245⅓ feet; duty of engine, boilers, and pumps (lbs. of water raised 1 foot high by 1 cwt. of coals), 83,172,051.

Cost of pumping, including coal, stores, and labour (working expenses), ¾*d.* per 1000 gallons; rates, sundries, and repayment of capital and interest for works described, costing 54,700*l.*, 3¼*d.*; making the total cost of the water supplied the by new works, 4*d.* per 1000 gallons.

Addington Village is supplied directly from the pumping main, and the pulsation of the pumping was intensified on the end of one of the 3-inch branch service mains, sometimes so much as to vary at each stroke from 40 feet to 330 feet on the pressure gauge, and to burst lead service pipes, of which the parts adjoining afterwards stood without rupture 1500 feet head. This pulsation has since been entirely neutralised by placing a small air-vessel at the spot and connecting the service main with it.

## Addington Reservoir.

This is a covered service reservoir upon Addington Hills, 87 acres of which belong to the Corporation of Croydon.

The hills are composed of the water-worn round pebbles and fine sands of the Oldhaven or Blackheath beds, and the best of these materials from the excavation were chosen for the concrete, a portion of the sand being removed by screening.

The entire structure, with the exception of the rendering and

the asphalt on the covering arches, is of Portland cement concrete, without any puddle backing, and as the work is found to be perfectly watertight, a few details of its construction will be interesting to the Association.

The reservoir is constructed to hold 5,000,000 gallons; the contour of the ground causes it to be oblong, the size being 420 feet by 124 feet by 16¾ feet deep.

The seven covering arches run lengthways, and have a span of 16 feet with a rise of 4 feet, and rest upon walls consisting of piers and arches 2 feet thick. The outside walls are 6 feet thick at the base and batter to 4½ feet thick at the top. The covering arches are 1½ feet at the crowns and 3 feet at the springings.

The floor, outer walls, and roof are mixed six to one by measure, the piers and arches of the longitudinal and cross walls, up to the springing level of the covering arches, five to one, a little Thames sand being used to make them set sooner.

The concrete was hand-made, turned over twice dry, wetted from a rose, and thoroughly mixed on wooden platforms. It was placed in its final position with a shovel, so that the coarse and fine parts of the concrete were mixed equally together, and also well worked to ensure solidity throughout. Water was rather freely used, but not so as to stand on the surface of the concrete when in position.

For joining up the work when it was set, grout made of one part of cement to two parts of sand was used, and, when necessary, the old work was cleansed, roughed over with a pick, and brushed before the grout was applied.

The floor is 18 inches thick, put on in two layers, the joinings overlapping.

The inside of the outer walls, which required to be roughed, and the floor, were carefully rendered, the first coat ½-inch thick with cement and washed Thames sand, in the proportion of one to one of each; and the finishing coat ¼-inch thick of neat cement, put on before the first coat was quite set, and thoroughly well trowelled to a smooth hard face. This cement was well cooled before being used. A double thickness of rendering is laid under the piers and on the springing of the arches against the outer walls. The rendering may be said to line the inside of the reservoir in every part of it up to 6 inches above overflow level.

Before they were rendered, fifteen slight vertical cracks appeared in the outer walls. These were cut out in a V shape, with a cross

sectional area of about one square foot, and filled in with good concrete.

Careful examination since the reservoir has been in use, fails to detect the slightest fracture in the rendering in any part of the work.

The outside of the covering arches forming the roof is covered with asphalt, ¾ inch thick, in two coats breaking joints, and is found to be watertight.

The spandrels of the arches are inclined from the centre to the ends of the reservoir, with 3-inch land drains laid on them to carry off surface water, and about 2 feet of earth covering is placed over the crown of the arches.

A division wall 12 feet high across the reservoir, with arrangements for using either side when the other is empty for cleansing or repair, is found to be very convenient.

The main from the pumping station enters each division at the springing level of the covering arches; this is also the overflow level, and is 465 feet above Ordnance datum, and 87 feet above the highest part of the borough. A water-cushion is formed on the floor under each inlet, by walls 2 feet high inclosing a space 10 feet by 6 feet.

Messrs. Kirk, Knight, and Company, of Sleaford, were the contractors, and the work could not have been done better.

The surface of the hills over the reservoir has been restored and planted with heather as before. Many were afraid the reservoir would spoil the contour of the hills, but now that the work is completed all are satisfied with the result.

No daylight is admitted into the reservoir; it is not needed, and it would cause the water soon to be green with a vegetable growth.

For the protection of the reservoir and the hills, a caretaker's lodge has been built over the entrance to the reservoir, with a covered shelter surrounding it. The view from the site, on a clear day, is very extensive.

### *Water Mains.*

The pumping main is 21 inches in diameter; the delivery or service mains to connect up the old water mains and to give a supply for public purposes beyond the two mile radius, vary from 18-inches to as small as 3-inches, according to their position, and end at Norwood New Town, a little further off than the Crystal Palace. The total length laid in the new works is 13½ miles; the

weight is 2,454 tons. The price, coated and delivered at East Croydon Station, averaged about 78s. per ton.

They were all laid by the Corporation workmen, rod-lead being used in jointing instead of gasket. The greatest pressure in the mains is 345 feet, and I am pleased to say only one burst has occurred hitherto in this work; an experience which is exceptionally favourable.

Telegraphic communication is established between the well and our Croydon works. Kempe's automatic apparatus transmits every inch of rise and fall in the reservoir, registering it on a clock-dial in the engine-house, and similarly to Croydon; where it is also registered on a diagram worked by an eight-day clock.

The levels of the low-level reservoir are similarly registered on the same diagram paper.

The cost of the new works has been as follows, viz.:—

| | £ |
|---|---|
| Addington Well, 10,256*l.*; land, 500*l.*; buildings, 6385*l.*; pumping machinery, 4651*l.* .. .. .. .. | 21,792 |
| Reservoir, 14,205*l.*; caretaker's lodge, 910*l.* .. .. | 15,115 |
| Water mains, 15,281*l.*; telegraph, 528*l.* .. .. .. | 15,809 |
| Sundry expenses .. .. .. .. .. .. | 1,984 |
| TOTAL COST .. .. .. .. | £54,700 |

## DESCRIPTION OF THE OLD WORKS.

The old waterworks are in the valley, close to the town of Croydon. Four wells are sunk in the chalk within a space of about 100 feet square, and over 3,000,000 gallons a-day have been pumped from them, the level of the water in the wells being then not more than 25 feet from the surface. The chief springs are about 50 feet deep.

The water is supplied just as it is pumped. The lift is 160 feet to the low-level reservoir on Park Hill. It holds 950,000 gallons, so it will easily be seen that it required good machinery and management to give a constant supply under such conditions. Pumping scarcely ever stopped excepting for oiling, but now, with the new works, pumping is not required on Sunday.

The district for the supply of water for domestic purposes is that part of the borough comprised within a two-mile radius of the Town Hall, and a population of 75,000; but for watering roads, flushing sewers, and other public purposes, we supply the whole

borough. The water supply is constant and has been so for many years. Last year the daily consumption averaged 2,391,589 gallons.

*Detection of Waste.*—Our system is somewhat unique. For fifteen years, night examinations have been made between the hours of midnight and five a.m. by listening for sounds of waste at stop-cocks on the footpaths, and where heard examining the water-fittings next day. By this means the consumption has been reduced from 48 to 32 gallons per head per diem.

Our subsoil is very variable, and is not favourable for either wrought iron barrel or lead services; defective ones in both materials are submitted.

Our charges for water supply are as follows:—8*d*. in the pound per annum on the rateable value, with an addition of 5*s*. per house when the rateable value is not over 12*l*., and 8*s*. per house when it is over. No extra charge for baths or w.c.'s. Garden hose, fountains, trade supplies, 1*s*. per 1,000 gallons.

No department is debited with any charge for water, such as watering roads, flushing sewers, baths, &c., and besides these allowances, a profit of about 3,200*l*. last year was available for assisting the rates.

The capital expenditure on waterworks is 153,533*l*.

The population of the county borough is 100,000.

The area of the county borough is 9,014 acres.

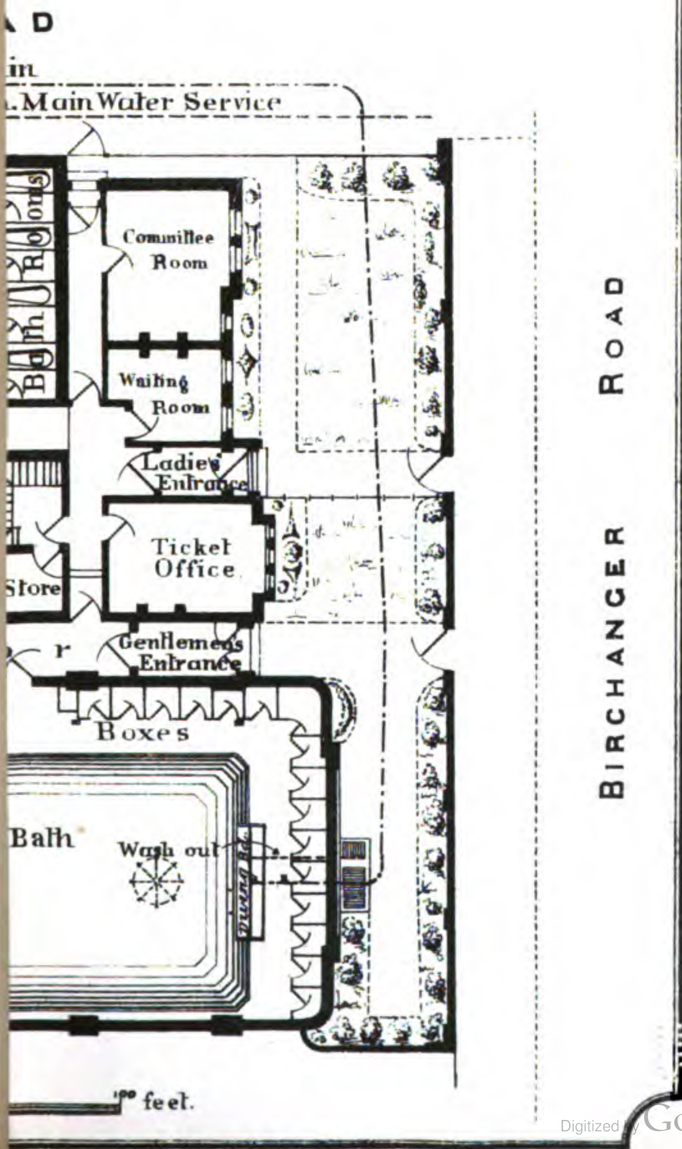
The rateable value, general district rate, is 533,000*l*.

The rates for Corporation purposes for current year, excluding police, is 2*s*. 7¼*d*. in the £.

## DISCUSSION.

Mr. C. Jones, in opening the discussion on the paper, said: I think there can be no necessity for taking the subject in detail, and the time is too short to say much in any remarks which may be made upon it; but I am sure all those who have gone through this interesting paper have not only gathered up a vast amount of information about Croydon, but have gathered information which will be generally useful to them in the work they come in contact with—whether it is sewage work generally, sanitary, bathing, and all that concerns that particular department, or waterworks and pumping machinery. The paper in itself is an abstract of

## ...nd Public Baths.



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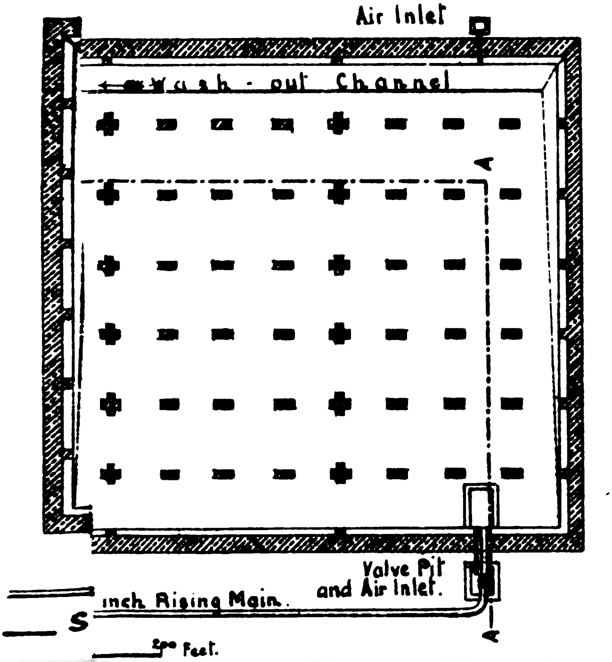
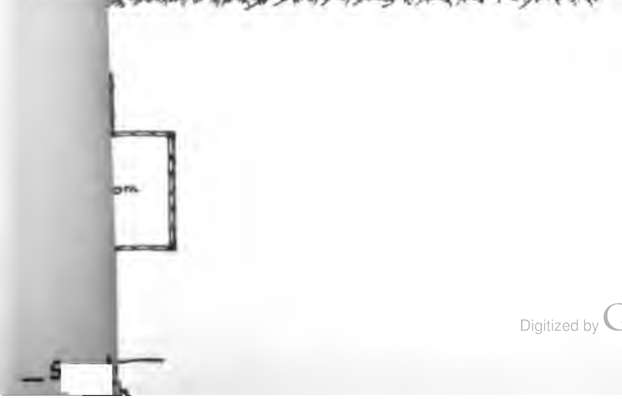


Air Inlet
Wash - out Channel
Valve Pit
and Air Inlet.
inch Rising Main.
S
Feet.


overflow

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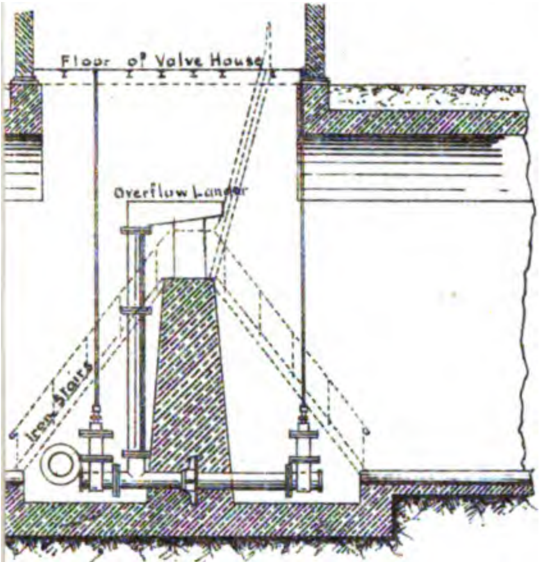
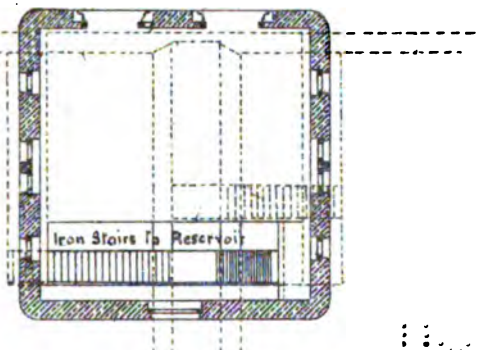
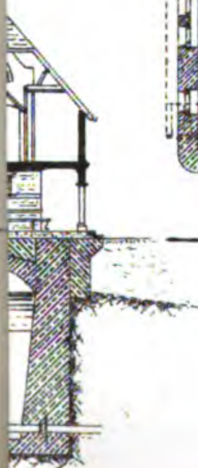



SECTION THRO. SUMPS & PARTING WALL




ENLARGED PLAN OF VALVE HOUSE

Section of Wash-out Channel.



40 FEET

a valuable series of works which have been designed and carried through to completion under the supervision of our friend Mr. Walker. It is not often that we have such a mass of interesting details put before us in one paper, and particularly I should like to refer to the illustrations which have been put in, and which have added so much to its value. I throw out that hint to those who are preparing papers, so that illustrations may occupy a more prominent position in our Proceedings than they hitherto have done.

Mr. McKie: I wish to say one or two words of thanks to Mr. Walker. Those members who assembled in the lower house took the opportunity of doing that honour to our worthy friend which the upper house—the House of Lords—did. There was not one in the lower house but who felt he had received an intellectual treat to-day. For myself I felt I had abundant testimony of it. In the paper there is nothing said too much, and there is nothing left out. It is as much like the man as two peas can be alike. Not only have we had an intellectual feast, but Mr. Walker has provided for the inner man, and that I think to the satisfaction of all present. I had thought of making some few observations on what Mr. Walker has done, but so completely does it agree with my own opinions of work that what I could say would not add to the knowledge of those present. Therefore, as one of those in the lower house I wish to say for them that we have received to-day, both intellectually and in every way, that which we expected to receive when we came to visit Mr. Walker.

Mr. T. De Courcy Meade: I won't trouble you with many remarks, but having also been in what Mr. McKie terms the lower house, I think it only right to say that downstairs we did return our thanks to Mr. Walker for the excellent way in which he treated us; and I can only say if you were as well treated upstairs as we were treated downstairs, you did very well indeed. With regard to the paper, there is a vast amount of interesting detail given in it of the various works carried out in Croydon. I cordially agree with the remarks of my friend Mr. Jones, that there is not a member of this Association, even if he wished it, who would have an opportunity of making any remarks at all detrimental to the designer of the works we have seen to-day. Everything we have seen seems to my mind to be as near perfection as is possible to bring it. I don't suppose there is another tank in England like the splendid concrete tank we have seen to-day. You will all agree that it was a bold scheme to carry out in concrete, and a great thing

to carry it out without a single crack. I am informed that since the tank was opened for use not a single crack has shown itself in the concrete; the cracks which always come in concrete in working, were noticed at the beginning, and made good. If there had been anything serious, there is no doubt those cracks would have shown themselves in a wider form. Mr. Walker and the contractors may congratulate themselves that they have carried out a splendid piece of work. I am sure the baths, especially the outdoor baths, must be a very great advantage to the people of Croydon. There is one thing that struck me about the baths, and that is, they might make the cost of the cheap baths less than 3*d*., so that persons with limited incomes might enjoy a swim in that beautiful blue water we saw to-day.

Mr. Hodson: I should like to say a few words with respect to the waterworks, and particularly as to the method by which Mr. Walker obtained a supply of water and ensured its permanence. I know, when these works were projected, it was freely stated they would not yield water in the quantity required. Now it is very evident to me as a geologist, and having a large experience in the construction of waterworks, that not only has he placed his works so as to obtain a supply, but has also carried them out so as to ensure its permanence. They are so situated as to command the underground flow from a very extensive gathering ground, where the water can be intercepted as it flows from the higher to the lower levels. In the sinking the water was first found at a depth of 87 feet from the surface, insuring at all times that thickness of filtering chalk down to the zone of saturation; Mr. Walker then sunk down 55 feet below the zone of saturation before he commenced his headings, thus commanding an underground reservoir of that depth. With these conditions present it was an absolute certainty that in chalk strata with its numerous fissures he would obtain the quantity of water he required, in fact it became merely a question of driving headings to cut through the fissures through which the water could obtain access to them. Being well below the zone of saturation he has the pull upon the strata during the hours of pumping, and there is no doubt he has obtained a good supply, which will be permanent, unless and until it is affected by other waterworks in the neighbourhood, or by exhaustive pumping in the deeper levels of the chalk nearer London. With respect to the reservoir which we have seen, I certainly think that to build a reservoir of that depth with concrete is a very perilous undertaking

—principally for the reason that with local authorities it is the invariable practice to advertise for tenders for carrying out the work, and generally to accept the lowest. Now contractors sending in the lowest tender are sometimes very queer people—queer financially—often inexperienced, and occasionally dishonest—you may get a good one, or you may get a bad one—I have had all sorts, and I repeat I would not make a reservoir of this kind with concrete, unless I could choose my list of contractors, or have the power of purchasing the materials and absolute control of their preparation. Mr. Walker has designed his work well, and has had the good fortune to meet with contractors who have carried out the work well and honestly. His design was thoroughly sound, and has been soundly executed, but very little dishonesty would have induced a failure serious to Mr. Walker's reputation; but fortunately he got contractors with a reputation to lose, and they have not lost it at Croydon. Although I have seen this work so well carried out with the present conditions, by which contracts are let by tender, I shall still stick to the old brickwork and puddle, which can in most districts be done at less cost per 1000 gallons, because of the reduced thickness of the walls. But the work here has been done satisfactorily; all is well, and Mr. Walker and the contractors deserve congratulations on a great success.

Mr. Forder: I thoroughly agree with every word Mr. Hodson has said. I think it is important that the question of concrete should be understood. I carried out a reservoir in a similar manner to Mr. Walker, and that reservoir was a complete success. There was another reservoir carried out in the same town, and that was a complete failure, although the concrete when tested gave the same results. In the one case there was a good contractor, and in the other a bad one. The use of concrete for a reservoir such as we have seen to-day is a very risky proceeding indeed, and it cannot be too much impressed upon the members of this Association that it is so.

Mr. Geo. B. Carlton: If you take the majority of reservoirs in the United Kingdom, such as the one we have seen to-day, how many do you find that are not made of concrete? I venture to say that 90 per cent. are constructed with concrete entirely. Concrete will stand water; it is only a question of getting proper supervision and a good man who does his duty and looks after the mixing, and materials will give satisfactory results. I am very pleased to find with regard to sewer ventilation that Mr. Walker is able to show

that ordinary ventilating pipes supersede Keeling's sewer-gas destructor, because I happen to represent the adjoining parish, where the authorities, acting under my advice, have had 150 sewer ventilating lamps put up. When Keeling's system was first introduced and brought under my notice, I regarded it as an expensive experiment; a large quantity of gas at a great cost had to be burnt to get any thing like satisfactory results. I had previously turned my attention to ventilating lamps to supersede the ordinary street ventilators, and I found I could get the same result from an upward shaft, such as those I have erected at Beckenham, as Keeling gets from his destructor, without the additional expense of burning gas. It is to me very satisfactory when I find that Mr. Walker in his paper states that he gets 1852 cubic feet per hour of sewer air from ordinary ventilating pipes, especially when I can beat him by another hundred feet. Sewers, in my opinion, can be ventilated by pipes without introducing the burning of gas. I wish to compliment Mr. Walker as to the condition of the sewage farm. The farm, unfortunately, is in my parish, and I naturally take a great interest in it, and like to see how the effluent drains are working and the crops growing. I am sure, so far as I am concerned, it is giving me satisfaction, and all credit is due to our friend Mr. Walker. There is, in my opinion, no sewage farm in the country worked better than this sewage farm. I do not know whether members looked at the effluent at the outfall this morning, it was a very lovely colour, a sort of yellowy brown. Certainly I have seen it a much better colour than it is to-day, and in a glass I have seen it as clear as crystal; but it will be said the rain has interfered with the works this morning, and that the land is not all being treated, owing to the changing and cutting of crops, and rye grass, etc. Many complaints have been made in Beckenham of the farm, but they have not been able to be actually substantiated. The Beckenham Local Board spent a large sum in fighting the Croydon Corporation when they went into their scheme for the extension by adding some forty acres; but Mr. Walker was able to show the Government Inspector that his effluent was A1, and he got his extension. I have to congratulate Mr. Walker upon the other matters enumerated in his paper.

Mr. Colam: When I came here as a visitor I did not expect to be called upon to make a speech, but at the same time I am very pleased at the opportunity of doing so, for two reasons. First, to express my gratitude to the Association (to which, unfortunately, I do not belong) for the opportunity of attending so interesting a

visit; and secondly to express my admiration of the machinery which I have seen at work to-day. Referring to the first part, I would say, as an engineer, that while we can learn a great deal out of books, our education is very incomplete unless we have an opportunity of seeing the works actually carried out and at work. I belong to an engineering society in London, which was perhaps the pioneer of visits of this kind, and that society has prided itself upon doing a great deal of good. But I see you Municipal Engineers know how to choose your visits. In my opinion you have been very fortunate in getting some of the very best places to visit. With regard to engines, my experience has been with very heavy machinery, and this visit has given me the opportunity of watching the improved details of such machinery. I have been very much impressed with the details of these engines. I am extremely pleased not only with their design but with their working. Gentleman, I again thank you for the opportunity you have given me to make this visit.

Mr. Eachus: I will only say one word, that is to testify not only to the character of the work as we see it finished, but I had the pleasure of seeing the work when in progress, and can testify to the great care and attention of Mr. Walker when he was carrying out the work. I am a believer in concrete, and I like to have the best materials for my concrete. Mr. Walker has done a bold thing here. He has used the native ballast, a round stone, and one that requires more care and attention than when you are dealing with Thames ballast. With that material he has succeeded in making a perfect piece of concrete work, and he has succeeded by seeing that every yard was properly mixed. The contractor has received his meed of praise, but he has to make money out of his contract, and it is necessary, if the work is to be properly done, for the engineer to give an efficient supervision to the work. Having seen the work complete I congratulate Mr. Walker upon his success; I also congratulate him upon the character of his effluent as we saw it on such a day as this. As far as I can judge the effluent he was turning out to-day was an exceedingly good effluent. I also congratulate him upon the work here, and upon the engines he has put up to lift his water; and I congratulate the makers upon the figures given here of Professor Kennedy's test, which was most satisfactory.

Mr. J. Barber: I have had to do with the construction of reservoirs, and have seen many constructed, but the present one has pleased me beyond any I have seen or had to do with. It

appears to have been built entirely of concrete, upon a hill of loose pebbles, and yet it shows no sign of a crack or leak; it is really a wonderful piece of work. With regard to other matters in the paper, it seems there have been some complaints as to smells arising from the sewage farm, from owners of property in the adjoining parish, but they have never been able to substantiate the justice of those complaints. I congratulate Mr. Walker both upon the construction of the reservoir and the condition of his sewage farm.

Mr. O. C. Robson: I wish to tender my evidence in favour of the value of concrete tanks. I have constructed several during the last thirteen or fourteen years, and in every instance there is not a single crack in them to-day. That is mainly due to thoroughly looking after the mixing of the concrete and the jointing of the various sections. With regard to ventilating shafts, I think Mr. Walker is to be congratulated upon having obtained sanction from the owners and occupiers of land in Croydon to place them against trees. In my own district I have sent out 250 circulars to owners asking permission to fix ventilating shafts against houses and trees, and the result has been seven answers assenting to it, and many very abusive letters at my suggesting such a thing.

Mr. E. Buckham: I wish to make one remark as to sewer ventilation, and to direct the particular attention of members of the Association to that portion of the paper in which Mr. Walker gives the result of his experiments with Keeling's destructor and ordinary pipe ventilators. Those results show how very careful we ought to be, when our friends come round with patent ventilators, before we adopt any system of ventilation which is likely to lead local authorities to an annual expense, because, as you know, Keeling's destructors cannot be adopted in any town without considerable annual expense. After Mr. Walker's experiments we should have no more ventilators which involve us in an annual charge on the rates.

Mr. C. Jones: in closing the discussion, said: I should like to add my testimony to the remarks which have fallen from other speakers in favour of concrete. Most of my work is done in concrete. The merit of the work is in the labour which is put into it, and the whole thing turns upon that. The same work and the same material may be used upon the same spot, and one work is worth a hundred per cent. more than the other. I am putting up large works now, and I know from experience that there are both

good and bad contractors. A contractor once said to me, "I have never made concrete like this in my life. What is the use of doing this?" and I said to him, "The use of it is this: you will be able to point to this work in years to come, and say 'I built these tanks,' and the other you will not want to look at." The labour that is put into concrete by the mixing of it, is what makes your work good or bad. The Keeling destructor was introduced first in my own district, but I make no remarks whatever with respect to it. I leave the results as obtained by Mr. Walker as being more thoroughly valuable than anything I could say, for I might be supposed to be biased. At any rate, Mr. Walker has carried out most thoroughly his experiments in this matter, and I have every confidence in him, and believe he is perfectly correct in all the data he has given us. The remarks which have been made as to the good work which has been done by Mr. Walker I thoroughly endorse.

Mr. Walker, in reply, said: I am very pleased indeed to hear your comments with reference to the reservoir and its construction. I admit we were very fortunate all round. We were fortunate in our contractors; and also in our clerk of works. But I attribute very much of the success achieved to the sagacity of our town clerk, who made it a condition that we were not to receive tenders from any firms who were not accustomed to such work. The Committee tumbled to it very sensibly, but the Council very nearly bowled it out. I had a number of people applying for quantities that were not eligible, and I told them so; even then we did not accept the lowest tender. The engine and pumps are a very excellent piece of machinery, and were designed by the firm who made them. I designed the buildings. There again we had a very fair contractor, but not quite of the status of the others. The reason we used concrete for the reservoir was that twelve years ago I put down a concrete sewer that was laid overhead in subsoil water. I started with the usual plan of four and a half of brick and 9 inches of concrete round it. When a short length was built, it was tested by blocking up each end, and allowing the subsoil water to rise outside, on going down a manhole on it, the water was seen spurting through the work in many places in a very amusing manner. Then I tried to point the water out, but found I could not do so. We then put it all in concrete—a mile of sewer 4 feet high—and when it was done, and surrounded by the subsoil water two feet deep at one end, and under water at the other end, it was found to be watertight, and so remains to this day. It was not let by contract;

I had three foremen from Messrs. Docwra, who were not busy at the time, and they saw that everything was properly mixed, and that the work was properly done. The experience I got there led me to use concrete for this reservoir. I am much obliged to my friend and neighbour (Mr. Carlton) for his remarks with reference to the farm. With regard to the colour of the effluent, it is possible he might see it where the road water is mixed with the effluent, and not the effluent by itself. When we had the enquiry we had people suggesting we were up to all kinds of tricks. The water in the swimming baths used to be let off at half-past nine at night, and that was put down as our emptying foul water from the sewage works. We cannot detain the sewage there for five minutes, or our sewers would burst. With regard to Keeling's destructor, if you will put an anemometer in the pipe between the sewer and the destructor, you will find that all that is told to you is not quite right. As to the price of bathing, we charge 2*d.* each, with the use of a towel, and we let our Board School children in for a halfpenny each. I do not think we could make it much cheaper than that.

Mr. Courtney: I think the experiments which were made by Professor Kennedy quite substantiate the remarks which have been made as to the efficiency of the machinery. I will merely call attention to one or two of the figures given in that test:—The coal burnt to the indicated horse-power per hour, 1·56 lbs., coming very close indeed to the best performances; the carbon value of coal equivalent per indicated horse-power per hour, 1·58; and the very remarkable figures of the temperature of furnace gases, leaving boiler 328·6° F., and entering chimney 171·6. The experiment was made by Professor Kennedy without any previous overhaul, and after eighteen months' working. The efficient lifting weight of the pumps was guaranteed as 95 millions, and they are doing about 15 or 20 per cent. more than that.

Mr. C. Jones: I wish to return you, sir, a very sincere vote of thanks for all we have heard, seen, and enjoyed to-day. We do not want to repeat words we have uttered, but I think I can say we have had a thoroughly good day at Croydon.

Mr. Walker: I can only say I am the debtor.

## CORRESPONDENCE.

Mr. F. Baker.—As to the Irrigation Farm I assume the quantity mentioned, 3,000,000, is only approximately the maximum; this would however give nearly 30,000 gallons to the acre, or in twenty-four hours this quantity would flood the whole area of the farm say 1½ inch in depth, not taking into account any rainfall on the farm. This, with such a subsoil, seems to me to point to the improbability that "anything in the nature of a storm overflow does not exist" in connection with the farm or the sewers. With regard to the detection of waste, this question has received prominent attention by waterworks engineers for more than twenty years, and the plan suggested in the paper was in practice at Sheffield, Norwich, and other towns, from about that time.

I am however somewhat surprised that although it has been in use in Croydon for fifteen years they have utterly failed to reduce the consumption to something like a reasonable quantity for a non-manufacturing town; the quantity is still far in excess of the usual standard of a well managed waterworks. When I was on the engineer's staff at Sheffield, the consumption was sixteen gallons per head per day for all purposes.

At Leicester, where large quantities of water are used for manufacturing purposes it is now only 18·10 per head per day for all purposes, 5·69 gallons of which is paid for by meter for trade purposes.

I may perhaps be allowed to add that, with a view to further reduce the consumption, special attention should be paid to the class of fittings, more especially water-closet cisterns; they are one of the chief causes of waste, and by adopting a good pattern of cistern, giving a thoroughly effective flush of two gallons, this, with a periodical inspection of all interior house fittings, will very soon reduce the quantity, 32 gallons per head, to something like a fair average consumption.

*The members first inspected the South Norwood Public Baths, in Birchanger Road. From the baths, the members drove to the South Norwood Irrigation Farm. Here Mr. Walker was generally congratulated on the character of his work and the condition of the farm. Heavy crops of rye grass were being cut and carted away from the farm at the time of the visit. The*

*members drove from the Farm to Addington Hills Reservoir, taking note en route of the shafts which Mr. Walker has obtained permission from the owners and occupiers of land to run up trees for the purpose of ventilating the sewers. On arrival at Addington, the members inspected the interior of the reservoir, constructed throughout of Portland cement concrete, to hold five million gallons of water. After the inspection, Mr. Walker entertained the members to luncheon. The members then drove through Addington Park to the Addington Well, where the pumping machinery was inspected.*

The following interesting particulars were supplied to members of a trial of the pumping engine made by Easton and Anderson, Limited, of 3 Whitehall Place, S.W., and Erith Ironworks, Kent, at Addington station of the Croydon Waterworks, by Professor Kennedy, F.R.S.

NOTE.—*Since the engine started in June,* 1888, *the spare bucket and clack have been put in the well pump, and the reservoir pump has been examined, in May* 1899. *Beyond this it has not been in any way overhauled, or examined even for the trial, which took place in its ordinary course of work.*

| | | |
|---|---|---|
| Date of trial | | April 17th, 1890. |
| Duration of trial | | 10 hours 3 minutes |
| Type of Engine | | Compound beam |
| Cylinder diameter— | High pressure | 20·0 in. |
| „ „ | Low „ | 33·97 „ |
| Piston stroke— | High „ | 47·9 „ |
| „ „ | Low „ | 71·8 „ |
| Pump diameter— | Well pump | 19·25 „ |
| „ „ | Reservoir pump | 19·0 „ |
| „ stroke— | Well pump | 71·87 „ |
| „ „ | Reservoir pump | 71·8 „ |
| Boilers.—Number of main boilers | | 2 |
| Type | | Cornish, with Galloway tubes |
| Furnaces, total number | | 2 |
| Heating surface, total | | 914·8 sq. ft. |
| Grate area „ | | 35·74 „ |
| Mean boiler pressure, above atmosphere, per sq. in. | | 98·41 lbs. |
| Mean admission pressure, high pressure cylinder above atmosphere | | 96·8 „ |
| Mean effective pressure, high pressure cylinder | | 57·6 „ |
| „ „ | low „ | 8·58 „ |
| „ „ | reduced to low pressure cylinder | 21·78 „ |
| Mean vacuum in condenser | | 13·48 „ |
| Revolutions per minute, mean | | 19·92 |
| Mean indicated horse-power, high pressure cylinder | | 85·8 H.P. |
| „ „ | low pressure cylinder | 55·5 „ |
| „ „ | total | 141·3 „ |
| Coal burnt per minute | | 3·67 lbs. |
| „ | hour | 220·08 „ |
| „ | square foot of grate per hour | 6·16 „ |
| „ „ | heating surface per hour | 0·24 „ |
| „ | I.H.P. per hour | 1·56 „ |

| | |
|---|---|
| Carbon value of coal as used .. .. .. .. .. .. .. .. .. .. | 1·01 lbs. |
| „ equivalent per I.H.P. per hour .. .. .. .. .. .. | 1·5 „ |
| Temperature of furnace gases leaving boiler .. .. .. .. .. | 328·6° F. |
| „ „ entering chimney .. .. .. .. | 171·6 „ |
| Feed water per minute .. .. .. .. .. .. .. .. .. .. .. .. | 38·24 lbs. |
| „ „ hour .. .. .. .. .. .. .. .. .. .. .. .. | 2294·4 „ |
| „ „ square foot of heating surface per hour .. .. .. | 2·51 „ |
| „ „ pound of coal, actual .. .. .. .. .. .. .. | 10·42 „ |
| „ „ „ „ from and at 212°, including economiser .. .. .. .. .. .. .. | 12·50 „ |
| „ „ „ „ from and at 212°, including economiser | |
| „ „ „ „ boiler alone .. .. .. .. .. .. | 11·88 „ |
| „ „ „ of carbon value from and at 212°, including economiser .. .. .. .. .. .. | 12·38 „ |
| „ „ „ of carbon value from and at 212°, boiler alone .. .. .. .. .. .. .. | 11·72 „ |
| „ „ I.H.P. per hour .. .. .. .. .. .. .. .. .. | 16·24 „ |
| „ „ total pump horse power per hour .. .. .. .. | 20·28 „ |
| „ „ net „ „ „ .. .. .. .. | 20·85 „ |
| Feed temperature before economiser .. .. .. .. .. .. .. | 57·2° F. |
| „ on entering boiler .. .. .. .. .. .. .. .. | 119·8 „ |
| Head of water, reservoir pump, actual .. .. .. .. .. .. | 157·0 ft. |
| „ „ including friction .. .. .. .. | 162·5 „ |
| Mean head of water, well pump .. .. .. .. .. .. .. .. | 91·25 „ |
| Work done in pumps, total including friction, &c. .. .. .. .. | 113·16 H.P. |
| „ „ nett .. .. .. .. .. .. .. .. .. .. | 110·04 „ |
| Total water pumped to reservoir per minute .. .. .. .. .. | 14634 lbs. |
| Mechanical efficiency of engines .. .. .. .. .. .. .. .. | 80·1 p. ct. |
| Ratio of water lifted per stroke to capacity of pump per stroke .. | 99·8 „ |
| Velocity of water in pipes per minute .. .. .. .. .. .. .. | 97·34 ft. |
| Length of rising main .. .. .. .. .. .. .. .. .. .. .. | 9,500 „ |
| Water raised, 100 ft. per lb. of coal .. .. .. .. .. .. .. | 9,895 net lbs. |
| Duty (ft. lbs. per 112 lbs. of coal) .. .. .. .. .. | 110,823,000 „ |
| „ ( „ „ „ ) including friction, &c. | 113,244,000 „ |
| Rat eof transmission of heat through boiler surface per square foot per minute .. .. .. .. .. .. .. .. .. .. .. .. .. | 53·74 Th.U |
| Jacket water per I.H.P. per hour .. .. .. .. ... .. .. .. | 1·92 lbs. |
| „ „ minute .. .. .. .. .. .. .. .. .. .. .. | 4·92 „ |
| Rise in temperature of condensing water .. .. .. .. .. .. | 2·208° F. |
| Quantity of condensing water per minute .. .. .. .. .. .. | 14,873 lbs. |
| Mean height of barometer during trial .. .. .. .. .. .. | 29·09 in. |
| „ atmospheric temperature during trial .. .. .. .. .. | 51·3° F. |

# DISTRICT MEETING AT EDINBURGH.

**September 26th and 27th, 1890.**

*Held at the Royal Scottish Society of Arts, George Street, Edinburgh.*

H. P. BOULNOIS, PRESIDENT, *in the Chair.*

The following papers were read and discussed :—

## MUNICIPAL WORK IN EDINBURGH.

BY J. COOPER, ASSOC. M. INST. C.E., BURGH ENGINEER.

IN former and more warlike times the invasion of Scotland by the English produced memorable and spirit-stirring events. The proud self-contained Scotsman was wont to be roused to heroic effort for the vindication and assertion of national dignity and liberty. His sturdy independence of character was largely fostered by those patriotic times. It is now matter of history that the two nations have long since joined hands and hearts, and have acted and reacted upon each other with good results, insomuch that they are now largely unified. Still, Scotland may well contend that those former visits of your ancestors—whatever might be their intention—have only resulted in good, and created for her a history and for us an ancestry of which we have every reason to be proud.

Gentlemen, we warmly welcome you on the occasion of your first visit to the Scottish capital, as we regard it as one of great importance and interest to Scotland.

Every member of your honourable and useful Association is entrusted with the charge and superintendence of numerous important

matters vitally affecting the health, comfort, and well-being of a community. Each man has devoted himself to the investigation and acquisition of all kinds of scientific knowledge, and of such professional and practical experience as may be likely to be of service in promoting the health, comfort, or convenience of that community which has entrusted him with these responsibilities. And some of you are veterans in engineering and sanitary research; and have been long in the field of arduous labour; and are rich with the stores of acquired experience.

You will bear with Scotland, gentlemen, if she seeks to despoil you of some of this knowledge and experience: you shall return to your homes none the poorer, and you will leave us so much the richer.

Scotland is at present represented on the roll of your Association only by a trinity of members, while the number on your roll is 383. But the Scriptures assure us that a threefold cord is not quickly broken, and I feel confident that before you visit us a second time this number will be largely increased. It ought to be increased *at once, tenfold.*

Some of our borough surveyors are meeting with us on the present occasion, and these will no doubt promptly recognise and acknowledge the advantages arising from being members of this Association, and admit their obligation by handing in their names as members. In case, however, that too much be expected from Scotland, we must keep in mind that her population at last census was only 3,735,573.

At the present time eight of the principal cities and towns represent a population of 1,345,563 as follows:—

| | |
|---|---|
| Edinburgh | 271,135 |
| Glasgow and suburbs | 530,208 |
| Dundee | 166,027 |
| Aberdeen | 123,600 |
| Greenock | 79,312 |
| Leith | 78,538 |
| Paisley | 63,469 |
| Perth | 33,274 |

These more important centres of enterprise and activity have long been actively promoting sanitary reform, although a certain amount of apathy may have hitherto prevailed in the country districts. Now, however, the election of County Councils throughout the country, under the provisions of the recent Local Government Act, the re-arrangement of administrative boundaries, and

the appointment of sanitary officers, has become general, and the results will be actively beneficial. The one thing awanting for a fair start being made, is the absence of a general Health and Building Act for Scotland in harmony with modern requirements. Let us hope that Parliament will shortly provide us with the sinews of war by passing such a measure as will enable Scotland to inaugurate an era of advanced sanitary reform.

I dare say you will have judged, that in adopting the wide field of Municipal Work in Edinburgh as the subject of a paper, I am unaware of the scope of such a subject, and mean to bore you with a discursive and general description of things neither interesting nor instructive. But on the occasion of a first visit to our city it seems to be necessary to give a bird's-eye view of our methods of conducting the work with which you are familiar at home, so that you may be able to estimate our position on the chart of municipal progress—that you may point out from your own experience where we might do more, or do better; and probably, by warning or deduction, you may receive fresh impulse and some lessons for your own guidance. I do not know how it is with most of the cities and towns which you represent, gentlemen. I take it, that in some measure you will admit a similar experience; but I am convinced that whether activity or passivity may have reigned in Edinburgh in the past, she is now entering upon a new era of wider enterprise and events of greater importance than ever before. For example:—

1. In her immediate neighbourhood there has just been carried to a successful issue that magnificent conception and world-renowned feat of modern engineering and mechanical skill, the results of the joint and prolonged and anxious labours of our two eminent engineers, Sir John Fowler and Sir Benjamin Baker—of whom we are all justly proud—and of the executive contractor and mechanical engineer, Sir William Arrol (a Scotsman, by the way). Edinburgh has been suddenly created an emporium of traffic and a halting place for travellers, insomuch that our railway stations have become congested, and unequal to the demands made upon them. The railway companies and the municipal authorities are at this moment earnestly considering schemes for increased and suitable accommodation, and further facilities of through traffic; a problem rendered all the more difficult because the utilitarian is so liable to interfere with and damage the æsthetic and natural beauties of our fair city, and further because an opportunity is thus

presented for laying the basis for a scheme capable of adapting itself to all future public requirements of railway station extensions.

2. The manufacture and supply of gas, previously in the hands of private companies, was only acquired two years ago, and already the question of an electric lighting scheme is being forced upon the authorities, and a modified scheme is about to be promoted in Parliament.

3. The horse tramways of Edinburgh will shortly have reached the twenty-first year of their existence, and in terms of the General Tramways Act the acquisition of the undertakings has been decided upon by the authorities as being the most effectual method of safeguarding the public interests. As Mr. Colam will tell you, and as you will shortly see for yourselves, two schemes of cable tramway are now working successfully and with great acceptance on the part of the community on the steep slopes on the north sides of our city, and, as the result of this success and convenience, the cable system will no doubt be introduced by and by on other streets where horse traction is difficult, and the sacrifice of horses very great.

4. The rapid increase of the city, and the general introduction of sanitary appliances on the water-carriage system, has gradually overtaxed our water supply, and although in the enjoyment of a daily supply of 15,300,000 gallons, which is at the rate of 40 gallons per head per diem, we are on the eve of the introduction of an additional supply.

5. The authorities are also applying to Parliament for further powers for the better controlling of the laying out of streets, the erection of houses, the sale of articles of human food, the more effectual prevention of infection, the promotion of greater cleanliness in poor houses, and other sanitary matters.

But now a rapid review of the municipal history of Edinburgh. The present population is 271,135. The area embraced by the municipal boundaries is 6166½ acres. This area includes of public parks and recreation grounds 1171 acres. In 1881 the population was 236,002. In 1871 it was 197,581. The annual rate of increase at present is something like 6000, or thereby. The average rate of density of population, exclusive of the parks and public recreation grounds, is 54 persons per acre. The maximum rate of density, viz. 900 persons per acre, is naturally to be found in the well-known Cowgate district, although it too is rapidly changing its appearance, and is largely becoming depopulated. The rateable

alue of property within the city is 1,905,000*l.*, last year's assessments being 2*s.* 1½*d.* per £ of rental, of which 7½*d.* was paid by owners, and 1*s.* 6*d.* by occupiers. For the coming year this rate will be reduced 2¾*d.*, a saving having been effected on road and sewer maintenance.

Gentlemen, you will probably have heard of the Battle of Flodden, which took place some four hundred years ago, when the Scottish army was not quite so successful as was desirable. After that battle a scare took hold of our historic city, and it was then that her inclosing city walls were erected.

The area thus inclosed was only some 146 acres in extent, and it was within this limited area, and for the sake of mutual protection and defence, that our dense narrow closes and high towering lands of houses, at which you must have gazed with awe, if not with admiration, found their origin.

At last, however, the growing city broke down these artificial barriers and stretched away afield on all sides, until at the present time, for statistical and other purposes, it is divided into three large divisions, viz. Old Town, New Town, and Southern Suburbs. Those times were marked by a generally social, convivial, and friendly spirit arising from the necessarily constant intercommunication of all classes of society, and the extremes of poverty and dilapidation now so prevalent throughout the slum district of our as well as other large cities were unknown, and thus those environing walls and the common interests of self-defence successfully accomplished the solution of that ever-growing social and political problem which is to-day vexing and puzzling the minds of all thoughtful men, of how to overcome the antagonisms of classes. And in this connection it may be interesting for you to note what appears to have been in the master mind of James Craig, the architect of the New Town, who sought, in laying out his famous regular streets and squares, to alternate a poor street and a high-class street.

It would almost seem as if the architects and engineers of former days were not less, but perhaps more than now deeply imbued with the spirit of philanthropic and social reform.

But the practice of erecting flat upon flat, and of subdividing flats into numerous separate houses, has become the bane of our slums, and has left us an heritage of insanitary and disease-producing conditions which, notwithstanding every effort, are to this day prevalent and disastrous.

## Sanitary Improvements.

It will be of interest to hear of the work which has been undertaken and executed for the improvement especially of the Old Town. I show a map of a scheme, planned and carried out under the guidance of the late Dr. Wm. Chambers (a former Lord Provost and prominent citizen, of the firm of W. & R. Chambers, publishers), which cost the city 300,000*l.*, and unhoused 14,000 inhabitants. New arteries of light and air were thus opened up through the very heart of congested and disease-infected districts, and the foundation was laid for the further work which has been executed since then. The death-rate of Edinburgh previous to Dr. Chambers's Improvement Scheme was 27 per 1000; last year it was 16·54, or, taking the three divisions of the city, as follows:—

| | |
|---|---|
| New Town.. .. .. .. .. .. .. .. .. .. | 13·40 per 1000. |
| Old Town .. .. .. .. .. .. .. .. .. .. | 21·86 „ |
| Southern suburbs .. .. .. .. .. .. .. | 12·49 „ |

Our well-known medical officer, Dr. Littlejohn, who has always been in the forefront of sanitary progress, was an energetic supporter of this scheme, and happily has lived to see its beneficial fruits and reap the reward of his labours.

## Further Sanitary Improvements.

As a matter of course, the Chambers Improvement Scheme did not directly benefit intervening districts where the same insanitary conditions prevailed. But the overhauling of these districts has been persistently continued, and especially since 1879, when powers were obtained to compel the notification of infectious diseases on the part of medical attendants, and to deal summarily with all uninhabitable houses. This system of notification is now becoming, or has become, general throughout the United Kingdom, but Edinburgh has enjoyed its benefits for the last eleven years, and during that period the medical officer of health has thus been able to localise and isolate any district of the city where diseases happen to break out. An investigation as to the cause or causes of such outbreaks has thus been simplified and concentrated, generally with the best results. A fully equipped Infectious Diseases Hospital is of course an indispensable institution for the isolated and

medical treatment of such cases. The Edinburgh City Hospital is provided with 250 beds, and has separate wards for smallpox, diphtheria, typhoid, typhus, measles, scarlatina, and hooping cough, besides a probationary ward. This institution is taken advantage of by some of our best citizens, and always with much appreciation. The staff consists of a consulting physician, an experienced resident physician, 24 nurses, 33 female servants, and costs annually 6320*l.* As showing how desirous the citizens of Edinburgh are of stamping out infectious disease, it will be sufficient to state that 6523*l.* has been paid to medical practitioners during the last ten years for reporting such cases alone; that is to say, 52,188 intimations have been made, at 2*s.* 6*d.* each.

In addition to this institution there has been provided in a salubrious quarter at Musselburgh, 6 miles out of town, a convalescent home, where patients, and especially children, after recovery, are taken for a few weeks to recruit sufficiently to enable them to return to their homes fully restored to their usual state of health. The staff here consists of a lady superintendent and three female servants, and is under the charge of the resident physician of the City Hospital, the whole being supervised by the Medical Officer of Health under the direction of the Public Health Committee.

We have it on the authority of Dr. Littlejohn that the total zymotic death-rate has decreased during the last twenty years as follows:—

Average from 1870–1879 = 3·33 per 1000 of the population.
„ 1880–1889 = 1·82 „ „

The Public Health Committee has for several years maintained a spirited oversight of the poorer districts of the city, although the mortality and infectious disease statistics show that there is much yet to be done before all sources of physical if not moral deterioration be rooted out. The following particulars will give an idea of the amount of work done in this direction—

| | |
|---|---|
| Number of uninhabitable houses dealt with during the last five years | 2000 |
| Number of houses closed as being uninhabitable | 1006 |
| Number of tenements of houses where water-closets have been introduced by order of the authorities | 1100 |
| Number of sinks, ditto, ditto | 650 |
| Number of tenements where the drains and sanitary appliances have been overhauled and put into good order | 3400 |

—at a cost to the owners of 57,000*l.*

I am strongly of opinion that the condition of the slums and

poorer districts of a city is a very fair measure of the extent to which its civic rulers and officials are conscientiously alive to their duty.

The lines of action followed by Edinburgh, to which I have referred, may not have been pursued so actively as is desirable, but the plan of her action is intelligible, and the results have been so far satisfactory.

First of all, the ratepayers at their own expense have opened up through the slum districts a framework of new streets and broad thoroughfares, shedding the light of heaven on the homes and haunts of the poor; thereafter they proceed persistently but gradually—so as to avoid the infliction of hardship—to deal with uninhabitable and insanitary property situated in the intervening districts, but on this occasion at the expense of the owners, and still further letting in light and air by acquiring properties incapable of rehabilitation, and forming select little playgrounds for the little slum "Arabs." This action on the part of the authorities has been warmly supported by some of our best citizens, and societies have been formed to aid in the work—one society preceding the authorities in their work of inspection, and another following in the wake of the Public Health Committee, acquiring and taking charge of such properties as were condemned where the owners were unable or unwilling to put it into habitable repair.

In the light of what scientists tell us (but which we do not require to be told), viz. that the light of heaven is by far the best agent for destroying or removing the germs of disease, the action of Edinburgh has all been in the right direction.

We have several good examples of schemes of houses for the working classes at rents from 6*l*. and upwards. We have also experimented with one small scheme of model dwellings for the very poor, containing some 33 houses, with rentals from 6*l*. 10*s*. to 9*l*. It is situated in the West Port, a district where such accommodation is much required; but the cost of acquiring the site has handicapped the scheme itself, and entirely prohibited any further effort in the same direction.

On the other hand, Edinburgh, like other large cities, is surrounded by a cordon of feuing land, which has, by her gradual enlargement, become increased in value—insomuch that its acquisition for providing housing for the working classes or the very poor is impossible, even were it not protected by exclusive and prohibitory conditions.

Surely it is high time that the authorities of such cities were invested with reasonable powers for the acquisition of land suitable for feuing out for this purpose, so that this cankering sore in the very heart of our great cities might be gradually weeded out, and that a decided lift to a higher plane might be given to all those who are at all capable of being rescued, and in any case for the benefit of the young. Those of you who are familiar with this question will not regard such proposal as Utopian. A community which is very properly compelled to provide gaols, poorhouses, and lunatic asylums, should have the power of protecting itself effectually and economically by arresting, when possible, the first causes for the need of these establishments at their sources, and turning them in a healthy direction.

The royal commission apppointed to inquire into the condition of the working classes in Scotland in 1885, recognise this same grievance, and one of their recommendations is as follows:—"A reform which would have a marked effect would be the reduction of the cost of the transfer of land, and that of small houses, which, in connection with the feuing system, renders the building of workmen's dwellings very expensive, and puts great difficulties in the way of the labouring classes either possessing their own houses or obtaining good accommodation at a low rent."

On the question of the duty of a local authority to provide suitable dwellings for the poor, there is in Edinburgh considerable diversity of opinion, and serious opposition by the Magistrates and Council themselves. You will confer a boon upon us should you shed light upon this subject.

A word or two as to the action of the Edinburgh authorities with regard to the inspection of the drainage and sanitary appliances of existing houses and buildings. As already indicated, further powers are to be sought in the ensuing session of Parliament for the prevention of overbuilding—by providing for greater width of streets, and more open ground in rear of houses, for limiting the number of houses in common stairs, for the oversight of subdivision of houses, and such like purposes.

All plans of new buildings, and alterations of existing buildings, must receive the sanction of the Dean of Guild Court, which sits weekly for this purpose. After the plans are approved and the building proceeds, the building inspectors, of whom there are four, each charged with a district of the city, visit regularly, from the time of the laying of the foundations to the completion of the

building, inspecting the work as it proceeds, especially the drainage and sanitary appliances; and on completion a certificate is granted that the whole work has been satisfactorily completed. Of course the builder who most requires oversight does not like to be inspected, but experience has proved that an intelligent inspection, maintained and carried out by judicious and competent men, is fruitful of the best results. The annual cost of this inspection of new houses and buildings, as above described, is 1000*l.* or thereabout.

As regards the drainage and sanitary appliances of existing houses, the same methods are pursued. It is the aim of the Public Health Committee to have the drainage arrangements of every house in the city examined and put into thorough order, in so far as this is not done voluntarily, and already nearly half of the city has been so dealt with. The Committee has also expressed its desire that all such work should be certified, as well as new houses. The certifying of new houses is provided for by statute, that of the drainage and sanitary arrangements of existing houses is only by desire of the Committee. The work is therefore followed up and tested by the smoke test as rigidly as possible, and the principle pursued is to ensure for each individual house complete isolation from the sewer as far as a waterseal and ventilated trap can ensure this; while by providing for ventilation to a safe point above the roof at the summit of each system, together with free ventilation by means of the various pipes, which are continued to a safe point above the roof, the house drains have as nearly as possible constant aëration. Although we have not explicit power as regards plumber work to insist on the best of materials as well as workmanship, the members of the plumbing craft in Edinburgh, during the recent movement for the registration of plumbers, have shown themselves to be deeply imbued with genuine feelings of self-respect, and this movement they have warmly welcomed as a means of elevating their standard of trade workmanship. The force of public opinion, and the sure knowledge of inspection, and the risk of a certificate being withheld if asked for, are also powerful agencies for good, and no builder of any standing will persist in indulging in scamped work. I dare say, gentlemen, you will be disposed to question the expediency of a local authority thus investing itself with so much responsibility in the matter of certifying houses to be in a sanitary and healthy condition; but I can assure you that, however great theoretical difficulties may appear to be, in our experience of the

system no practical difficulties have been met with of any moment.

The annual cost of inspecting the drainage arrangements and sanitary appliances of *existing* houses is 1800*l.*, or thereabout. The staff consists of three inspectors of experience, each with a small squad consisting of a mason, plumber, and handy labourer, with all necessary implements.

I should like here to refer to the advantages of having leaders of advanced views and convictions in sanitary matters. In Edinburgh, four years ago, we reaped very considerable advantages through the appointment of the late Sir James Gowans as Lord Dean of Guild. His first work was to abolish for ever in new houses the old-fashioned dark, confined, and inconvenient common stairs; dark and insanitary conveniences located in the centre of houses; as far as possible the erection of pipes and the formation of drains within the walls of houses—in short, he waged eternal war against the possibilities of dirt or darkness, offensive smells and drain gases. He insisted successfully on having all water closets and other appliances placed next, if not outside of the outer wall, with windows of reasonable dimensions; he proved to a demonstration that common staircases with well-holes for light of a superficial area of not less than 32 feet, and a roof-light of over 100 superficial feet, were all in the best interests of both builder and prospective purchasers and tenants. He convinced all parties that it was possible and most advantageous to keep all drains and pipes outside of dwellings, or nearly so. He insisted on the sites of dwelling-houses being overlaid with bitumen, and, speaking generally, on soundness of construction. His memory inspires us still; others remain with us similarly equipped and qualified, who have drunk of his spirit,—and I am sure the Association will feel that it is our duty to do our utmost in the way of supporting these gentlemen, who, with much self-sacrifice and self-denial, labour disinterestedly, and too often thanklessly, for the public good.

## Sewers and Sewerage of Edinburgh.

In an ancient city like Edinburgh, of gradual growth and laxity of supervision in the earlier stages of its history, its sewerage system, like other things, slowly and gradually developed, and somewhat like the laws of the United Kingdom, has ultimately

become a somewhat intricate and complicated matter. The city is naturally divided into three large drainage districts, each with a particular stream for its outfall. Until twenty-five years ago, when an intercepting pipe sewer was formed by Messrs. D. and S. Stevenson, the whole area coloured blue on the map before you, which is 2760 acres in extent and contains a population of 130,000, drained into the water of Leith, which flows through Edinburgh and Leith, and discharged itself into the harbour of Leith. The result you can imagine. But, as a qualifying circumstance, it must be remembered that the method pursued in those days with regard to house drainage was to intercept the solids by means of cesspools periodically cleaned out by the cleaning staff, and added to the other city refuse, the liquid sewage alone passing into the stream.

This pipe, which cost 70,000*l.*, and was chiefly laid in the channel of the river, discharges its contents—which, augmented by the sewage of Leith, amounts to an average of 1360 cubic feet per minute—into the sea beyond low-water mark at the eastern end of Leith. This pipe has served its purpose for a quarter of a century, and was paid for by an assessment over the area drained, at the rate of 2*s*. 6*d*. per £ on one year's rental. The extension of the city, and the continued increase of the water supply, has overtaxed this pipe so seriously, causing so extensive overflows of sewage into Leith harbour and the river generally, that at the present moment a comprehensive scheme for the purification of the river is proceeding, which I will afterwards describe. *The yellow area* embraces, as you see, the central and eastern sections of the city—the outfall being still, owing to the continuance of irrigation, an open stream.

The discharge is an average of 800 cubic feet per minute, and it drains an area of 1455 acres, with a population of 120,000 persons.

This open sewer flows through Lochead meadows and the well-known Craigentinny meadows. These meadows adjoin the seaboard between Leith and Portobello, and are 250 acres in extent. The distributing conduits have, of course, been laid with some care as to levels, so as to convey the sewage over the whole ground; but beyond this, no further skill is applied in the use of the sewage for surface irrigation. The meadows are simply flooded with sewage from time to time as required, which gradually flows off and finds its way into the sea at intervals, by no means

clarified. No part of the farm is specially prepared for intermittent filtration.

Of course the ebb of the tide, and the strong currents in the Firth of Forth, have the effect of keeping the beach from becoming actually offensive from the discharge from the meadows, and the great mass of the sewage, other than that used on the meadows, is carried out beyond low-water mark by means of a large iron pipe.

The cost of maintaining these meadows is not more than the wages of one or two men, who look after the flooding and maintenance of the sluices and conduits. The crops are chiefly Italian rye, realising at present a return of 25*l.* to 30*l.* per acre per annum. A few years ago it was not unusual to obtain 40*l.* to 45*l.* per acre. The grass is sold in lots at the beginning of the year to neighbouring dairymen and cowkeepers. The owner of these meadows uses the sewage without let or hindrance, and of course pays nothing for it.

You may probably agree with me, gentlemen, that the city of Edinburgh would have been wise to have possessed itself of those meadows long ago. But it requires very exceptional qualities on the part of short-service civic rulers to legislate for posterity (Edinburgh Town Councillors are elected for a period of three years), and of course the value of the meadows is now greatly enhanced and almost prohibitory. Craigentinny Meadows Irrigation is, however, one of the oldest and probably one of the best illustrations of the value of sewage in its application to land by irrigation—a large part of the meadows being purely drift sand reclaimed from the sea, while there has always been a free discharge over the entire length along the foreshore. This state of matters cannot continue much longer.

These meadows, however, fail to shed any light on the vexed and troublesome question of sewage purification, such as the borough surveyors of inland towns are all too familiar with.

The third outlet is the Powburn, which drains the southern suburbs of the city—an area of 1800 acres, and a population of 21,000.

Until the year 1885 the sewage of this district flowed openly to the sea at Portobello, which some of you will know as a nice little bathing-place and summer resort. Portobello recently raised an action under the powers of the Rivers Pollution Act, and compelled the city of Edinburgh to spend 40,000*l.* in the construction of a large culvert for the conveyance of the sewage to the sea at a

considerable distance from their shores. The work was completed two years ago. The sewage in this outlet is also used for irrigating an area of 48 acres, and the owners of the same also have the sewage free of charge, returning the effluent in a very unclarified state to the sewer.

The sewage of Edinburgh, to the amount of nearly three millions cubic feet per day, is thus, with these exceptions, drained into the Firth of Forth, to become food for sea-gulls and fishes; and probably, in view of the enormous trouble and outlay in which many cities and towns are involved in order to get rid of their sewage, you will consider that she is fortunate in having such facilities, at least until some reasonable and adequate return can be obtained from its purification or manipulation otherwise.

A word or two as to the large purification and sewerage scheme which is presently being carried out for the purification of the water of Leith. The waters of this river, or rather stream (for it has a very small volume, except in spates), have a very polluted appearance as flowing through Edinburgh. This is due to the fact that seven villages discharge their sewage, and five paper mills (where the manufacture of paper from esparto grass is regularly carried on), pour their noxious discharges of ley and other matters into the river, imparting a brown, coffee-like colour to the waters, which are almost constantly overspread with a persistent froth and scum, caused by the churning of the water by the water-wheels at the various mills. The Corporations of Edinburgh and Leith, and the local authorities of the various parishes, along with the mill-owners, have by representatives formed themselves into a Board of Commissioners, who have devised and are in course of carrying out a general drainage scheme for the intercepting of noxious discharges referred to, and for the enlargement of two already existing compensation reservoirs for the replenishing of the river by means of a regulated and constant flow of pure water.

The sewer will extend from the village of Balerno to the sea at Leith, a distance of 13 miles. At its commencement it will be formed of an 18-inch diameter pipe, gradually increasing in capacity and strength, until at Leith its internal size will be 9 feet 3 inches by 7 feet 2 inches.

The outfall over the foreshore to the point of discharge will be 5-feet diameter cast-iron pipes, supported by greenheart piles driven to a depth of 10 feet.

The culvert is formed of Whitehill machine-pressed composition

brick, set in cement 1 to 1, with a 1-inch intermediate ring of cement between the two rings of brickwork. But where extra strength is necessary an outer ring of cement concrete, 5 to 1 and 7 to 1 is laid. Where exceptional strength is required, and to ensure against any interference with the sewer where affected by tidal action, flanged sectional curved metal plates are being used, with a strong casing of concrete. (See plan.)

The dimensions and gradients of the sewer have been arranged so as to ensure that when the whole area is fully feued and occupied, it will receive and carry off five parts of storm-water to one of sewage, before any overflow into the river occurs, and of course in such case the river itself will be in flood.

The point of discharge will be at low-water mark at ebb tide, and at full tide will be covered with 17 feet of water; the sewer will, however, even at full tide, discharge at its mouth 4418 cubic feet per minute. For relief during heavy rains an overflow is formed at the point where sea and land meet near the Docks breakwater. And the various branch sewers, at their points of junction with the new sewer, have regulated overflows, so that it can only receive a fixed maximum quantity.

The urban part of the work is being executed by the Burgh Engineers of Edinburgh and Leith. The cost of this work, as estimated for, is 90,000*l.* The total length of sewer to be executed under this offer is 4·86 miles; the average cost per lineal yard is therefore 10*l.* 10*s.*

The landward part of the works, including the enlargement of the reservoirs, is being executed by Messrs. Leslie and Reid, C.E., Edinburgh, which cost is estimated for at 54,400*l.*

Had time permitted, gentlemen, you might have paid a visit to part of those works.

The cost will be distributed over a period of 30 years, and will be paid in the following proportions:—

Edinburgh, in proportion to its annual rateable value.

Leith, ditto, but excluding the docks.

Landward parishes, in the proportion of four times their annual value, and the Paper Mills, at the annual rate of 2*s.* 3*d.* per £ of rental.

## Sewers in the City.

*The ordinary sewers* of Edinburgh are of all kinds. In the Old Town the sewers were generally renewed twenty to thirty years ago, but only those which have been newly formed or reconstructed within recent years have been ventilated. In the New Town they are for the most part stone-built culverts of large dimensions, and not so smoothly surfaced or graded as is desirable; at the same time the available gradients are good, and the flush copious and unobstructed, and little deposit or silting occurs.

You may believe, however, that keeping in view that paramount question with the ratepayers, viz., the taxes, we shall not rest satisfied until those questions are effectively dealt with. The information as regards sewer ventilation, and the discussions thereon, which appeared in the prints of the Proceedings of the Association, have been most valuable. We are fully conscious of the necessity for having our sewerage system properly aerated and ventilated; but we are a somewhat fastidious people, and the sight of a street ventilator is so liable to give a nervous shock to our citizens, that we have first of all addressed ourselves most assiduously to the task of making all our house drainage as perfect as possible, and completely isolated from sewers and the effects of sewer gases.

## Edinburgh Roads, Streets, and Footpaths

are under the charge of Mr. Proudfoot, City Road Surveyor, to whose courtesy I am indebted for the following particulars.

The streets and roads of Edinburgh are 108 miles in length, and consist as follows: ordinary macadamising, chiefly suburban roads, 38 miles, maintained at an annual cost of 156*l.* 12*s.* per mile; of streets paved with whinstone and granite setts bottomed on sand, with gravel joints, 20 miles; of whinstone and granite setts as before, bottomed on sand and jointed with bitumen, 14 miles; same as above, but with the joints grouted with cement, 8 miles; of whinstone and granite setts bottomed on concrete foundation, and jointed with bitumen, 20 miles; of whinstone and granite setts bottomed on concrete, and grouted at joints with cement, 6 miles; of streets paved with cement concrete, 2 miles; of asphalte for carriageways we have none.

Eleven years ago Princes Street was paved at a cost of 15*s.* per superficial yard, in the following manner:—A foundation for the

tramway lines and causeway was laid down, consisting of a layer of cement concrete formed of 5 parts of broken stones and 3 of gravel to 1 of cement, and 9 inches in thickness, overlaid with a pavement of whinstone setts from Ratho and Ravelrig quarries, grouted at the joints with cement grout 1 to 1. Two years ago part of the surface had become so slippery and smooth by wear and tear that it had to be roughened for foothold with the pick. Notwithstanding that this carriage-way is 67 feet in width, the daily wear and tear of vehicle traffic has now worn its surface into very considerable depressions, and its renewal has already begun in part.

A stretch of beechwood paving properly seasoned and creosoted, 250 yards by 8 yards in width, was laid down last year, and with the exception that it becomes very slippery during wet, frosty, or muggy weather, and requires to be kept exceptionally clean, and occasionally sprinkled with sand or fine gravel, it is giving satisfaction. It is likely that the whole of Princes Street will be shortly renewed in wood, either beech or redwood. Of course the old concrete foundation remains good, reducing the cost of repaving to that extent; the cost of the beechwood paving, not including the concrete bottom, was 10*s.* 4½*d.* per superficial yard.

As regards wood paving otherwise, I confess that Edinburgh has never given this kind of paving fair play. At the present time we have only two or three short streets, where noiselessness is of first importance, paved with it. At the beginning of the era of wood paving we did try it on one or two of our busy thoroughfares, but as the wood blocks were simply laid on the original criss-cross wooden boarding, a seven years' trial was deemed sufficient, and we again fell back on the whinstone setts.

We have tried cement concrete paving for a few level and a few cul-de-sac streets and back courts. Its first cost is about 6*s.* per superficial yard.

It has the advantages of being smooth and easily cleaned, and but for the clatter of the horses' feet is comparatively noiseless. A further advantage (and for the poorer districts an important one) is that the children of the adjoining houses can play themselves in the same, especially in the quiet streets and back courts.

Summing-up generally our experience of the various kinds of street paving in use with us, we find that granite (Aberdeen) when properly bottomed is the most durable, and, viewed with reference to the mere question of construction and maintenance, the cheapest.

But after a few years' hard usage the setts become rounded on the surface like cobble stones, and the noise, and tear and wear on horses and vehicles, are seriously increased.

Whinstone from the quarries in our neighbourhood in the west, Ratho and Ravelrig, may be regarded as the next in order for cheapness. Although, when laid on a concrete foundation, it wears quickly under heavy traffic as in Princes Street.

On the other hand, when simply laid on a sand bed, on the ordinary consolidated soil, a period of four or five years of ordinary heavy traffic is enough to cause great irregularity of surface.

At the present time our civic rulers and citizens are contemplating the adoption of a smoother paving material than either of those two above described—in so far as this is attainable without raising a new danger in slipperiness.

We shall be glad to hear from you whether this is to be attained by the more general adoption of wood, asphalte, or other smooth paving material; or whether persistent and sustained inspection, and timely repair, or both, are required to accomplish all that is desired.

The cost of the Roads Department in salaries is 1137*l.* 12*s.* per annum, and consists, in addition to the office staff, of six inspectors and 115 workmen.

All the heavier works and cartage are executed under contract. All rolling of macadamised roads is presently performed with a 2-ton horse roller, the 20-ton steam roller formerly in use having been found to be too heavy, and is now used at the Roads Depôt for driving the stone-breaking machine for macadamising purposes. A 10-ton roller has been proposed, but has not yet been acquired.

## Foot Pavements.

Previous to 1879 the foot pavements of the city were maintained by the owners of the adjoining properties. By the Act of that year powers were obtained for the Magistrates and Council assuming the maintenance of the footpaths of the public streets, the cost being defrayed out of the burgh assessments. The carriage-way and footpaths of all private streets must of course be properly constructed before being vested in the Magistrates and Council.

The paving materials in use are:—Craigleith and Hailes flagstones, Caithness flagging, and cement. What is called Hornising

—that is, the insertion of whin chips on edge and blended—has now been discontinued because of the discomfort to pedestrians. Craigleith flagging, although a most desirable pavement, is also disused, owing to the quarry being worked out. White Hailes flagging is a laminated stone which wears fairly well, and affords a good foothold, and is therefore much used in sloping streets. Its cost laid complete is 11½*d.* per super foot.

At present we are laying down extensive stretches of cement paving, the estimate for such work during the current year being 2800*l.* Its first cost is 3*s.* 4*d.* to 4*s.* per super yard. It has a clean appearance, and is much appreciated by the public. When well laid it wears with us under considerable traffic, as on the south side of Princes Street, for 11 or 12 years, with comparatively little appearance of wear. The annual cost of the public foot-pavements of Edinburgh, extending to 200 miles, is 7500*l.*

One feature recently adopted by the road surveyor in laying cement footpaths, is the formation in one, *in situ*, of the kerb and water-channel of this material. The cost of this method is 5*s.* 6*d.* per lineal yard as compared with 7*s.* 3*d.* per lineal yard, the cost of the former method of laying hewn whinstone water-channels and kerb.

### Our Method of Cleansing

in Edinburgh is comparatively simple, and, as conducted under Mr. Geo. A. D. Mackay, cleaning inspector (who took charge of the department 18 months ago), very efficient indeed. We have no middens nor storage of house refuse. This necessitates a system of daily collection and disposal.

The cleaning staff consists of the chief inspector, assistant inspector, 13 overseers, and 180 scavengers. The carting department belongs to the city, and consists of 50 waggonmen, 70 carters, and 120 horses. Annual cost of maintenance of the carting department, 13*l.* 17*s.* 4*d.*; of the whole department last year, 30,476*l.* 10*s.*; average weekly keep per horse, 12*s.* to 13*s.*

Daily each morning the dust-cart perambulates the city, picking up house refuse, street sweepings, &c., which is at once carted off either to a railway or canal loading bank, or to some tip or quarry hole in the neighbourhood of the city. All householders are on the alert to have their bucketful of refuse at the door before the dust-cart passes, and so before 9 or 10 o'clock each morning this cleaning-up process is complete. The household refuse is of a light kind,

consisting of ashes, vegetable and other refuse, offal, &c. It has little manurial value now that water-closets, and even public conveniences, are fitted up on the water-carriage principle; and of late years there has been experienced a growing difficulty in realising anything for the sale of it, and now it has to be taken to the farmer's door, costing the city for railway transit from 3*d*. to 5*d*. per ton.

Five years ago investigation was made by a deputation who visited various towns in the midland counties, with reference to this question, especially as to the cremation of house refuse, and it was found at that time that unless some return could be derived from the clinkers, or by the utilisation of the waste heat of the destructor, the burning of each ton of refuse would cost, inclusive of capital outlay, something like 10*d*. per ton. It was therefore decided, at that time, to continue the disposal of the material to farmers as before.

Again, however, another deputation of the Council is making further inquiry as to the experience of other towns in this matter. This question is, therefore, also at present an undecided one, viz.—as to whether we are to continue to dispose of house refuse to farmers as at present, or whether it can be more cheaply cremated, taken out to sea by means of barges, or applied to some waste or moorland in the neighbourhood, or tipped into a neighbouring quarry hole. A dozen horse-brushes perambulate the principal streets every night between the hours of 12 and 4.30, the sweepings being picked up by the dust carts as they pass in the morning.

During warm and dusty weather 18 water-butts are set agoing, using the ordinary water supply for this purpose.

Careful attention is also given during the spring and summer months to the lime-washing and cleaning of closes and back courts in the poorer districts of the city.

I will close my paper with a short résumé of the powers as to formation of streets and erection of houses which we are proposing to submit for the sanction of Parliament next session.

We are asking, as follows:—a minimum width of street of 40 feet instead of 20 feet as at present. The height of houses to be one and one-quarter times the width of the street, instead of one and one-half times as at present, the new standard to be from the pavement level to the roof of the highest habitable room instead of from the pavement level to the eaves.

The open ground in rear of new buildings to be three-fourths of

the area built over. When the buildings exceed three storeys in height, said open ground to be equal to the building area.

At the present time there is no limit to the number of dwelling-houses in any new tenement. Powers are asked to allow no more than twelve dwelling-houses where the common staircase is *within* the buildings, and twenty-four when there is an outside stair with balconies.

At present the subdivision of one large house into two or more separate houses may proceed without the sanction of the Dean of Guild Court, and powers are being sought for the Court to have jurisdiction and control in this matter.

Power is also being sought to enable the Corporation to take lands and heritages compulsorily for the widening, enlarging or otherwise improving any street, or for making new roads, paths and accesses, subject to a petition to the Sheriff for authority to put in force the powers of the Lands Clauses Acts with reference to the acquisition of lands otherwise than by agreement. The foregoing, along with a code of building regulations, are the principal matters affecting streets and buildings.

Many other matters might be described, such as our public baths, slaughter-houses, and other public buildings, but your time is too valuable. I have only to thank you for hearing me so patiently.

# EDINBURGH NORTHERN CABLE TRAMWAYS.

By WILLIAM NEWBY COLAM, Vice-Pres. Soc. Engineers, Assoc. M. Inst. C.E., M.I.M.E., &c.

It is with the greatest possible pleasure the author finds himself in a position to respond to your Secretary's invitation to lay before you on this occasion a paper describing the cable system as it is worked in this city. There are reasons why this may be considered a very opportune occasion for the Association to have such a paper laid before it. Firstly—In these days of competition, entailing rapid street transit with reduced fares, it becomes necessary to seriously consider the motive power which is likely to meet modern demands. Secondly—The cable has been at work over an extended period in Great Britain, and it is now easy to show that the system, as worked in this country, establishes the favourable reputation it has made for itself in America, Australia, and elsewhere. Thirdly—A better opportunity is given the members to form an opinion when the subject of the paper is to be seen in operation.

In a visit the author made to America some years ago, he formed a strong opinion that the cable system would have a future in this country, and for the past nine years it has been his particular study to introduce cable tramways into Great Britain. In endeavouring to do so, he has frequently had the pleasure of discussing, with members of this Association, cable tramway construction as it must be to receive the approval of such of you whose duty it is to look after the maintenance of public thoroughfares. It is hoped that the members present to-day will approve of the construction to be described, as resulting from experience gained under such auspices.

The first design for a cable tramway on this side of the Atlantic was prepared by an American gentleman sent over for the purpose, and as the author was closely associated with him in the preparation of the plans, he is able to confidently say that it is well for those interested in the cable system that no line was built on those plans.

The American designing cable tramways for Great Britain had to be taught, as Mr. Train was in 1857, that construction interfering with road surfaces has to be made amenable to British ideas and customs. The author believes that the restrictions imposed on cable tramways by your worthy Vice-President, Mr. Meade, while approving of the plans at Highgate, will be found to be of benefit to the system in this country, as the new condition necessitated the subject being re-thought out, and has resulted in the mode of building being made much more economical as well as more suitable for our streets. It may be that, as Americans are now following our example in adopting the grooved in place of the step rail, they may learn from us that cable tramways are to be substantially constructed for one-third of the cost they have hitherto thought it necessary to expend on systems which would not meet with European approval.

A cable tramway may be described as an arrangement of details which enables street cars to make use of a wire rope concealed in a tube below the road surface, and kept constantly moving in one direction at a given maximum speed from a power station. By means of gripper mechanism connected with a car, and working through a ⅝-inch slot in the road, a driver can cause his car to be propelled at the maximum speed of the cable, or at any reduced speed desirable. From this it will be readily understood that the economy of a cable tramway must increase with the increase of traffic, and its expenses in working per ton mile must decrease with every additional ton mile added. The power expended in providing the means of propulsion at various points along the route is a constant charge, but the percentage of that charge to the total power required for operating the whole system depends entirely upon the ton-mile of traffic. This feature in the system at first appears to be its weak element, but in practice it is found to be quite the reverse, excepting when the system is put to work in districts quite unsuitable to it, and of course any tractive force would compare unfavourably if similarly treated. A tramway motor, to be a good caterer to the public, should be capable of meeting increased traffic at a minimum cost, and this the cable is specially able to do, seeing that after the fixed charge is provided for, every additional ton imposed on it requires but a small increment to the net power. Again, hilly districts are practically reduced to level roads, because descending cars being attached to the cable assist the engines in overcoming the extra

work imposed by ascending cars. The author has a strong conviction that it is quite easy to make people ride by giving increased facilities, and no system of street traction enables this to be done at so small a cost as the cable.

Before proceeding to the more immediate object of this paper, it may be as well to refer cursorily to some of the results of cable tramways abroad and in this country. When cable tramways were first introduced, it was to supply a communication between the City of San Francisco and its otherwise insurmountable suburban districts, but from the working of this first line up Clay Street, data was deduced which conclusively showed that the economical results obtained were applicable to level districts. San Francisco has now a most complete system of cables all over the city. The authorities of Chicago, which is an unusually flat city, lost no time in availing themselves of the new motor, with the result that they now have 52 miles of cable road, working at speeds of twelve and eight miles per hour, and the cost of running per car mile has been reduced from 23 cents by horses to 9½ cents by cable, big dividends having been paid on increased capital. Other cities in America slowly followed the example set by Chicago, and every inauguration has been attended with complete success, notwithstanding the unnecessarily expensive form of construction Americans have thought it necessary to adopt.

The time available for this paper will not admit of reference to all the places in the United States where the cable is doing good work, but it would be unjust to pass unnoticed the Brooklyn Bridge line. The traffic over this line is at certain hours of the day exceedingly heavy, and it is truly wonderful to watch the cable at such times dealing with enormous masses of people. Over this line 35,698,874 passengers were carried last year, and in one day as many as 159,259 were conveyed.

The most brilliant financial results have followed the inauguration of the cable system in Australia. In the streets of Melbourne last year 45,000,364 passengers were carried over 43½ miles of cable road, and the dividend earned was 75 per cent.

The cable system was unfortunate in its introduction into this country. The financing of the Cable Corporation, and the ill-chosen district for the experimental line, burked further progress with the system for over three years after the Highgate Cable Tramway was opened by the Lord Mayor of London in 1884. This line is only three-quarters of a mile long, and is practically

deserted in the winter; it, however, still is working well, and illustrates the system as laid with passing places. In the summer months it often carries enormous numbers of people, and works at less than 50 per cent. of its gross receipts.

The next line built was the first in Edinburgh. Then followed one in Birmingham, which has since been lengthened. Whilst this line was under consideration of the town authorities, the author was, for a length of time, engaged in disabusing the minds of the members of the Works Committeee on certain supposed constructional objections, and it was not until his suggestion was adopted, to lay a small piece of experimental road, that the consents were obtained. The returns from Birmingham show that the number of passengers carried last year was 4,261,050, and the working expenses by:—

| | | | |
|---|---|---|---|
| Horses | = 85·5 per cent. of gross receipts. | | |
| Steam engines | = 64·5 | „ | „ |
| Cable | = 46·5 | „ | „ |

The last line constructed is the second one in Edinburgh.

The introduction of cables is now being actively considered for several important districts.

The total number of miles of cable tramways in successful operation is 501, over which last year it is estimated that not less than 794,245,000 people were carried, or nearly twice as many passengers as were carried on the tramways of the United Kingdom.

## Edinburgh Northern Cable Tramways.

### *Description of Routes.*

*Trinity Route.*—This first line constructed meets Princes Street in Hanover Street, and proceeds north over the hill in George Street, and then descends the steep incline of Pitt Street. Passing Henderson Row, where the cables branch off to the engine-house, it takes curves of 195 feet and 80 feet radii, and crossing the old bridge of Canonmills, which is the lowest point on the route, it ascends easier grades to the Trinity terminus. The district round the southern half of the line is completely built over, and the northern section is being quickly developed since this line commenced operating. The cable passing along this line traverses eighteen curves, of radii varying from 80 feet to 980 feet, the smallest curve being less than a right angle. It is also diverted

at various places by nine large pulleys. The total height ascended is 187 feet. The length of track is 3 miles.

*Stockbridge Route.*—This line also starts from the main street of Edinburgh, and travels parallel and over almost identical grades as part of the other route. After passing round 100 feet curves into the Royal Circus, the lines are almost entirely a series of curves passing through steep and very narrow roads, thickly populated on all sides. The line then crosses another old bridge at Stockbridge, where the cable leaves for and returns from the engine-house; the route, though curvy for a time, is almost level. The cable on this line has to traverse 28 curves, of radii ranging from 80 feet to 400 feet; it also is directed by the same number of large pulleys as the other line. The total height ascended on this route is 173 feet, and the length of the track is 2·4 miles.

The engine-house from which these two lines are operated is in Henderson Row, 400 feet from the Trinity route, and 1650 feet from the Stockbridge route. In the first case, the cable coming into and going out from the driving machinery, travels in a closed tube to the main line in Pitt Street. There it is directed in from the right and out to the left. Arriving at Trinity terminus, it is diverted by an 8 foot 6 inch pulley to the return line. On passing Henderson Row again, the cable is not interrupted, but proceeds directly to Princes Street, where again it is directed down to the depot, by passing around another 8 foot 6 inch pulley. The Stockbridge cable, on leaving the depot, instead of passing into a closed tube, is conducted along a single line of cable track, and on arriving at Claremont Place there is a passing place. Proceeding south-westward, the cable going and returning still travels in a single tube, and passes round a gentle curve. On reaching the main line at Stockbridge, the cable dips under the up line, and is directed to the down line. At the two termini of this line the cable is diverted much in the same way as on the other route.

### *General Working.*

The cars operating the Trinity route take the cable at the up or down main lines. At Trinity terminus the driver opens his gripper and the cable is adjusted so that it leaves the gripper automatically. The return cable is taken after passing by gravity through the siding. The cable does not again leave the gripper until the siding at Princes Street is reached, when on opening the

gripper the car is taken by gravity to the end. When the car is required to leave, the cable is taken by simply lowering the gripper. On arriving at Henderson Row, where there is a break in the continuity of the cable, the gripper is opened and the car passes by gravity to the cable returning from the depot.

On the Stockbridge route the cars take the cable outside the depot, and travel along the single line and through the passing place to the commencement of the 60-feet curve which joins this single line to the up-hill track on the main line. Here the driver brings his car to a standstill, and almost at the same operation of releasing the main cable, he takes an auxiliary cable which is laid in this curve. He proceeds with his car around the curve at a reduced speed, and at a certain place on the main line stops again and takes the main cable. After this operation the mode of working is precisely the same as on the other route. Whilst referring to the plans adopted in these cases of working the cars at the termini, at the places where the cables leave and return to the tracks, and in passing round the 60-feet curve from the siding, the author wishes it to be understood that there are many other ways in which these could have been operated.

It must not be supposed that the author has considered it necessary to have an auxiliary cable to work cars round short curves. At the junction of the single line from the depot with the main lines on the Stockbridge route, powers were obtained to connect with two curves, but the author thought traffic at the corner was at times rather congested, and he decided to use only one curve to complete the connection. In adopting this plan, he has demonstrated the practicability of conveying the traffic over systems of cable tramways which may be receiving their motive power from machinery stations widely separated. By such a means, there is no reason why cable may not be adopted for working complete systems of tramways requiring cars to pass over varying routes.

## *Road and Tube Construction.*

The author has had prepared, specially for this occasion, full-sized representations of the road surface, and a cross section of the bed of road and cable tube. The road surface has been very faithfully depicted, in fact it is as nearly as possible a piece of the track itself, and requires no imagination to realise what is necessary to convert a horse line to a cable route. The author has also pro-

vided the shoe of an Edinburgh cab-horse, which is useful in comparing with the size of the necessary slot and rails forming it. It will be seen, as has been demonstrated by actual results, the slot construction cannot in any way be detrimental to street traffic. Cart-wheels crossing at acute angles over ordinary tramway rails, when the tread of rail has not worn equally with the guard, sometimes receive wrenches better known than appreciated, but at no time of the life of the slot can such be caused by the rails forming it. In the first place a tramway rail groove is 1 inch wide, and the corners are rounded. Secondly, the tread is always wearing, and the groove rounding more and more. But the slot is only $\frac{5}{8}$ of an inch wide, and the edges of rails forming the slot will always remain square as constructed at first. It will thus be seen that the narrowest wheels may cross the slot at any angle without the driver in charge being aware of their existence. From the full-sized cross section of the road and tube, it will be seen that the tube is made of concrete, and that the upper part of the construction, with the exception of slot, is little more than the ordinary track for a tramway to be worked by horses. The tube is 19 inches deep from the surface of the road, and $9\frac{1}{2}$ inches wide. In the concrete forming the tube are embedded, at intervals of 3 feet 6 inches, cast-iron tube frames, to which the slot rails are bolted. The cast-iron frames are all lined up in place before the concrete is poured in, consequently the whole becomes a homogeneous mass of concrete and iron, which prevents subsidences or closing in of the slot rails. The extreme over-all depth of the tube from the road is 26 inches. Under the bottom of the tube is laid a 6-inch clay pipe, which is connected with and drains recesses in the concrete. These recesses receive the pulleys for supporting the cable, and are placed 50 feet apart. The pulleys for conducting the cable round curves are of course spaced as experience dictates for varying conditions and radii. In dealing with sharp curves it is not necessary to have openings through the road to get at the pulleys. The author devised a subway between two tracks, from which pulleys may be renewed or adjusted. This has proved a most convenient arrangement, and was not costly.

The track rails are of an ordinary girder type, and are 6 inches deep, and weigh 75 lb. per yard.

The slot rails form an important part of cable construction. those used form the subject of a patent of the author's, and are intended to lessen the cost of tube construction, by reducing the

depth of tube, and forming in the rail itself a means of supporting the gripper in going round curves. This is done by setting back the bottom member of the rail, which allows a friction roller on the gipper to take the lower vertical plane to the right or left, according to the direction of the curve. These rails are made of steel, and weigh 39 lb. per yard. They are fished with plates on the outside only, weighing 34 lb. each.

The tube frames supporting the slot rails are made of superior cast iron. The centre web is 1 inch thick, and the whole weight is 135 lb. At each side there are recesses for receiving special ties for keeping the track rails accurately in gauge with the slot.

The supporting pulleys are 14 inches in diameter, and are made V shape in the tread. They are of cast iron, and are specially designed to be adjustable in the tube, and to absorb any sound created by contact with the cable. The journals revolve in boxed *lignum vitæ* bearings, with a special arrangement for lubricating. These pulleys have proved very effective in absorbing sound, and they will run three months without attention.

The pulleys for the curves are 14 inches in diameter, and are so arranged that the portion worn by the cable can be renewed without the more expensive centre. On the worst curves the outside sleeves of these pulleys last over sixteen months.

When two tubes are brought together, such as in the cases of the down lines at Princes Street running into the up lines, or where, as in Hamilton Place, a single line enlarges, for a time, into a passing place, the slot junctions have been constructed so that the slots need not be wider than $\frac{5}{8}$ inch.

The large diverting pulleys are made of cast-iron, with jaws bolted on in segments, with wood treads. They are built in segments to be removable in small parts.

The terminal pits for holding the diverting pulleys are built of concrete on the one route, and of brick on the other. Their internal dimensions are 19 feet long by 11 feet broad by 8 feet deep. The roofing is composed of rolled joists, jack arches, and buckle plates. On the Stockbridge route large sewers were found in the roads where it was desired to place these pits. The Burgh Engineer kindly gave his consideration to the matter, and a simple departure from the designs enabled the pits to be constructed without increasing their sizes, or injuriously affecting the sewers. The pits at Stockbridge and Henderson Row, containing the

machinery to divert the cable from and to the depot, are somewhat larger than the terminal pits. In many cases these pits would be entirely dispensed with.

The machinery in the Stockbridge pit is more complicated than the others, as it contains gear for driving the auxiliary cable working round the 60-feet curve. The power required to propel the auxiliary cable is derived from gear on one of the diverting pulleys, which is kept in motion by the friction of the main cable on the periphery of the diverting pulley. Whilst describing this portion of the route, it will be well to draw attention to the points where it is necessary to release the cable going to the depot, and gravitate to the portion of the cable returning from the depot. If a driver should neglect to do this, there is danger of injuring the cable. To avoid this, the author has designed a combination of electric bells and stops, which first warn the driver, and in case of his not heeding, bring the car to a stop. The apparatus works well, and is set in operation the moment the cable is removed out of its normal line of travel.

The cables now used on these lines are those known as Lang's patent, and are made by Messrs. Cradock and Co., of Wakefield. The author has now had considerable experience in working cables, and he is of opinion that there is not at present a better make, for cable tramway purposes, than the Lang lay. It is necessary to use a cable which will give a maximum amount of wear without fracturing the wires. This the Lang rope does by enabling, on a given diameter pulley, larger wires to be used, and at least the same flexibility as the old make of rope. The cable used is made of the very best patent improved crucible steel wire, laid round a hempen core, in six strands, each of 13 wires (7 round 6). The wires stood a tensile strain of 80 tons per square inch; torsional tests of 35 twists in 8 inches, and 4½ times bent over its own part. The lay of rope is 9 inches, and the circumference 3½ inches. Specimens of new and worn rope are produced. It will be noticed that, as the life of the Lang rope is extended, the frictional surface area increases, until it should eventually approach the appearance of a bar of steel, the lay of the wires in the strands permitting such wear without the wires being cracked on the crowns of the strands, as in the old form of rope.

The cars used are of the bogie type. They are fitted with two sets of powerful brakes, one set acting on all eight wheels, and the

other on the track rails. From the axles of the bogies are suspended the frames for receiving the grippers.

The grippers are a very important part of the mechanism in cable tramways. The one adopted in this case is a patent of the author's, who believes that a good gripper should possess the following features:—

1. It should require unskilled labour to operate it.

2. It should be removable from the car in less than one minute by the driver, without special tools, which may be mislaid.

3. It should be entirely detached from the cable when a car is at a standstill, so as to avoid unnecessary wear on the cable.

4. It should be able to pick up the cable at almost any part of the line without any special gear.

5. All parts wearable or breakable should be cheaply and quickly substituted.

6. The mechanism through which the driver applies his grip on the cable, should not be such as to admit of a sudden seizure of the cable, and thereby causing fracture of wires.

7. It should take up as little room as possible, to enable shallow tubes to be adopted.

8. It should contain a rolling arrangement for supporting the gripper in going round curves.

It is believed that this gripper complies with all these conditions.

Referring to the gripper, the driver in operating the hand-wheel raises or lowers a nut by the square spindle. Attached to the nut are two rods, which raise or lower the bottom jaw of the gripper, the upper portions of which slide through openings in the plate which has the upper jaw casting bolted to it. The plate rests on angles suspended from the axles of the cars, and is firmly held down in its place by wedges, which are forced in or out by the driver through screw spindles and inclined slots. When the wedges are withdrawn, the whole gripper will rise by the action of the hand-wheel. The bottom jaw can be lowered out six inches, and by that means the cable can be picked up, because the moment the rounded bottom of the jaw touches it, the cable ascends into its place in the gripper. The roller revolves on the slot rail on going round curves, and takes the torsional strain close to where it is created by the cable. The dies by which the cable is gripp ed are of the softest cast iron, and last on an average about six

weeks. The sectional area of the steel shank, where it works in the slot, is 4·92 square inches. These grippers have been found efficient at work and under the maintenance test.

### *Driving Machinery.*

It is very essential for the proper working of cable tramways that special attention be given to the selection of valve gear to be used. In this case the author selected that known as Dr. Proell's Automatic Expansion Gear, a small model of which is shown, and well illustrates the action. This valve gear has proved most effective in controlling the varying conditions of traffic, and requires very little attention. The valve gear and the engines, which are a pair of high-pressure horizontals, 20 inches by 40 inches, were made by Messrs. M'Culloch, of Kilmarnock. These engines are arranged so that either can work the two routes, and that one of the two routes can be thrown off or on without interfering with the other. The driving pulley used is 10 feet 6 inches in diameter, and of the V type, around which only a three-quarter lap is made with the cable. The jaw of the pulley is removable in segments, and is lined with white metal, which can be easily renewed when the cable wears to the bottom. The loss of metal is very little, as the segments are re-melted with a small addition of new metal, and poured again into place. The bottom of the V is filled with soft wood, upon which the cable bottoms. This arrangement has been found effective in preserving the cable in shape, without inducing slip. The cable goes direct to the driving pulley, around which it passes a three-quarter turn; it is then directed down again over an idle 10-foot pulley to the automatic tension pulley around which it takes a half-turn and leaves the engine-room. The effective weight on the tension is only 7 cwt.

From the foregoing description it may be observed that the Edinburgh Cable Tramways are working under the following varied conditions:—

1. On gradients as steep as 1 in 11.
2. Over perfectly flat roads.
3. Round small right-angled curves.
4. Over old bridges with the crowns not twelve inches from the road surfaces.

5. Two routes at considerable distances apart being worked from one engine in the same depot.

6. Single lines with passing places.

7. Cars being worked at reduced speed round a sharp curve.

In addition, cable routes abroad cross each other; cable cars run in conjunction with horse systems and take on the cars from the horses. There are, therefore, few circumstances met with in street traction that the cable has not conformed to.

The cost of constructing and equipping these lines for a three-minute service of cars has been as follows:—

| | £ | s. | d. |
|---|---|---|---|
| Track with tube, pulleys, &c., complete .. .. .. .. .. | 33,377 | 0 | 0 |
| Machinery buildings, offices, chimney shaft, &c. .. .. | 4,786 | 0 | 0 |
| Engines, boilers, machinery at depot and in pits .. .. | 5,103 | 0 | 0 |
| Cars and gripping machinery .. .. .. .. .. .. .. .. | 4,704 | 0 | 0 |
| Auxiliary cable gear .. .. .. .. .. .. .. .. .. .. | 850 | 0 | 0 |
| Cables .. .. .. .. .. .. .. .. .. .. .. .. .. .. | 1,260 | 0 | 0 |
| Payments made to city for paving outside tracks and to gas and water companies, and extras .. .. .. .. .. | 7,150 | 0 | 0 |
| Total .. .. .. | 57,230 | 0 | 0 |

In considering the results of working these lines, it is necessary that the following be borne in mind:—

(*a*) The Stockbridge route has only been at work since February last, and the full half-year's receipts have not been obtained on that line.

(*b*) Expenses inherent to the inauguration of a new line have been charged against revenue.

(*c*) On the one line the district is only thickly populated over one-half of the route.

(*d*) The fares charged are less than the rate of one penny per mile.

(*e*) The speed of cars at present is limited to six miles per hour.

(*f*) No tramways are allowed to run in Edinburgh on Sundays.

(*g*) The percentage for administration on a small line is always high, and in this case especially so. The author, therefore, in giving the actual results, also shows reductions on general charges as they would be if the lines worked in conjunction with a larger company.

## Actual Working Results, with Heavy Administrative Charges, for Half-Year ending 30th June, 1890.

*Expenditure.*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Motive power .. | | | | | 585 | 6 | 8 |
| Traffic expenses .. | | | | | 1100 | 12 | 4 |
| Maintenance .. | | | | | 940 | 14 | 1 |
| General charges:— | | | | | | | |
| Salaries .. | 370 | 0 | 2 | 100 | | | |
| Auditors .. | 31 | 10 | 0 | 12 | | | |
| Fire and other insurances .. | 26 | 11 | 4 | 20 | | | |
| Rates and taxes .. | 51 | 17 | 7 | 44 | | | |
| Gas .. | 20 | 17 | 4 | 20 | | | |
| Office stationary, postage, &c. .. | 59 | 16 | 8 | 10 | | | |
| Directors' fees .. | 94 | 17 | 10 | 60 | | | |
| Travelling .. | 54 | 14 | 3 | 10 | | | |
| | | | | | 714 | 5 | 2 |
| | | | | | 3340 | 18 | 3 |
| By balance .. | | | | | 2053 | 5 | 2 |
| Total .. | | | | | £5394 | 3 | 5 |

*Receipts.*

| | £ | s. | d. |
|---|---|---|---|
| By Passengers .. | 5328 | 0 | 0 |
| „ Advertising .. | 56 | 15 | 8 |
| „ Sundries .. | 7 | 15 | 3 |
| „ Transfer fees .. | 1 | 12 | 6 |
| Total .. | £5394 | 3 | 5 |

The reductions under general charges reduce the working expenses to 2902*l.*, which would be at the rate of 54 per cent., instead of 64 per cent. of the gross receipts. This result must be compared with 77, the average working percentage with horses over easy roads. If it be remembered that the routes in question are not yet thickly populated, it can easily be seen that the percentage may be far below 50.

The author believes that it is quite impossible for any vehicular traffic usually making use of the streets to be injuriously affected by the construction adopted on these lines, and that most of the conditions urban authorities would insist on have been embodied may be seen from the following:—

1. The slot in road is narrow, and not as to interfere with vehicular traffic.

2. The amount of metal presented in the surfaces of rails forming the slots is small, and yet strong enough to resist lateral and vertical strains.

3. The slot rails are supported by non-yielding metals, to prevent the slightest possible closing of slot under heavy traffic or atmospherical changes.

4. The pulleys are specially designed to make the noise due to the travel of the cable over them almost imperceptible, and they do not require much attention.

5. The hatches for obtaining access to the pulleys are small.

6. The whole of the driving gear is duplicated, to minimise risks of stoppages.

7. The form of construction is one admitting of rapid laying in the road.

8. The construction is shallow, so as not to interfere more than possible with existing pipes.

9. The average speed of cars is, under the circumstances, faster, and service more frequent, than it could be with horses.

The author desires to take this opportunity of publicly thanking Messrs. Dick, Kerr, & Co., Limited, of London and Kilmarnock, for the very thorough and unselfish manner in which they have carried out the whole of the work of constructing the tramways and machinery.

In concluding, it may be well to draw the attention of members to the many mechanical motors which have been tried from time to time for hauling cars, with more or less mechanical and financial success.

1. Steam locomotives.
2. Steam storage.
3. Gas engines.
4. Ammonia engines.
5. Pneumatic engines.
6. Compressed air stored in receivers on cars.
7. Compressed air supplied in pipes from a main station.
8. Cable system.
9. Electricity conveyed to motor cars from a main station.
10. Electricity generated at a main station, and conveyed through wires placed over the tramway tracks.
11. Electricity conveyed through conductors in tubes under the tracks.
12. Electricity stored on cars.

Only two of these, which have stood the test of time so necessary to properly ascertain motor depreciation, have been able to survive. They are the steam locomotive and the cable system.

The title of this paper, and the time available for its reading and discussion, will not admit of any special reference to motors which may be considered to be taking their trials as competitors for future street haulage; but the author respectfully submits that, during the last seventeen years, the cable system has firmly established itself as a reliable and efficient caterer to the public requirements, under fairly varied conditions. The financial results have also been so extremely satisfactory as almost to demand the attention of urban and tramway authorities.

## DISCUSSION.

The PRESIDENT: Before opening the discussion, gentlemen, I may be permitted to mention a little difficulty in connection with the papers. It would be well if authors of papers could let our secretary have them a little earlier, in order that they might be printed and circulated amongst members. Thus, the time taken up in reading them would be saved, and a proper discussion of the papers could take place. It would be impossible in the little time left at our disposal to properly discuss the papers which we have heard this morning. In opening the discussion, I beg to propose a vote of thanks to the authors of the two papers—Mr. Cooper, Burgh Engineer of Edinburgh, and Mr. Colam, of the Northern Tramway Company. Speaking of Mr. Cooper's paper first, as I hinted before, that paper is full of most discussable matters to sanitary engineers; and to deal with it properly would occupy, I think, the rest of the day. I will not detain you by drawing attention to many matters, but I shall first allude to one, where he speaks of the vexed question as to the providing of suitable dwellings for the poor. That, no doubt, is a very vexed question in all large centres. We at Liverpool have found that to be the case. We are every year spending large sums of money in the destruction or demolition of rookeries. At one time the Corporation of Liverpool erected artisans' dwellings. They have erected two large blocks, but they are doubtful whether these blocks are meeting the requirements of the really poor, and the people they displaced. So they are trying to sell land—almost giving it away—in order that other classes of buildings may be erected. But, I may say at present the scheme is not meeting with much success. There is another point in the paper to which I would like to draw attention, namely, the use of the Craigentinny Meadows. I must confess myself, I was much startled to hear by this paper that these far-famed meadows are not altogether the success which we have been led to believe they were. Perhaps in the reply Mr. Cooper will make, he will give us a little explanation of this matter. On the question of pavements, I would like to say that, in Liverpool, that question received considerable attention, and there it was decided, after much discussion, that Welsh granite setts should be laid throughout the city, and I may say that an extent of about two million yards of that class of pavement is now laid in the city with very satisfactory results,

excepting the noise. No doubt it is a noisy pavement, but in point of wear and the point of being impervious, it is the best class of pavement. Turning now from this paper, which I should like to still speak about, to Mr. Colam's paper, I think in this case we are deeply indebted to Mr. Colam. Here is an engineer who comes forward with a paper giving us the whole facts in connection with the work which he has been associated with—keeping nothing back from us, and telling us all that he has to tell; and I think it speaks well for any engineer who will come forward gratuitously, and will tell his brother engineers how he has made successful working tramways, or any work in which he has been engaged. There are one or two points on which I should like a little further illustration. He says there is no reason why cables may not be adapted for working a complete system of tramways, requiring cars to pass over varying routes. Perhaps in his reply he would make that a little clearer. I do not quite understand the analogy from what he said before. Mr. Colam mentions the saving in Australia between the horse lines and cable lines. I should be glad if he has any information that he could lay before us as to whether any comparative returns have been made in England in the same way. Of course, as we know, the success apparently of cable lines depends to a great extent upon the continuous amount of traffic and the life of the cables. I am sorry the time will prevent me from making any further remarks, and I have the greatest pleasure in proposing the vote of thanks that I began my remarks with.

Mr. Meade: Mr. President, I have much pleasure in seconding the vote of thanks to Mr. Cooper and Mr. Colam for their very excellent papers. Mr. Cooper's paper is certainly one of very great interest, and I think it will rank in the forefront amongst the useful papers that we have in the Minutes of the Proceedings of the Association. This being our first visit to Scotland, I think we have not come here without gaining a considerable amount of knowledge. There is so much in this paper that one would like to speak about, and so little time to do it, that I will confine my remarks to two points. One is the cost of the granite pavements of this city. Now, we in London look to Scotland for our granite pavements. In the City of London, after the experience of a number of years, it was decided that the most useful granite pavement—I am speaking of some years ago, when I was in the London office—was the Aberdeen granite sett. The other granite

pavements tried were found to be either too slippery and hard, or else they were not sufficiently durable. But looking at the cost, I find that the cost of paving in Edinburgh is not so much lower than what we used to pay some years ago in the City. As well as I recollect it cost about 18*s.* per yard, as against 15*s.* in Edinburgh. I should have expected that the paving in this stone city, the heart of the stone country, would have been far less than it appears to be. The other point I would like to call your attention to is the cost of disposing of the town refuse. I have gone very fully into the matter, and have seen most of the arrangements for destroying refuse, both in this country and in England, and I can only say that if it can be done at anything like the price put down here, the City Authorities will do well to hesitate before they go into another system, so long as they can avoid filling up low-lying lands which are likely to be built upon. It may be interesting to you if I give the exact cost of the working of the destructor at Hornsey. We have had many figures before this Association from time to time, but I can give you actual figures which cannot be gainsaid. The cost of collecting the refuse, exclusive of the provision of the horses and carts, is 10*d.* per load. A load varies from one and a quarter to one and a half ton. The cost of burning the same quantity is 1*s.* Now both the collection and the burning are piece work. So that you have got the actual cost, although you must add slightly under 1*s.* for interest on a loan for the cost of the works. That brings the cost up to something like 3*s.* In the adjoining district of Islington the cost is I believe about 3*s.* 6*d.* These figures are exclusive of the cost of working the cremator. Returning to Mr. Colam's also very excellent paper, he gives us an immense lot of very useful information, and I hope we will see the illustrations which accompany the paper printed in the Minutes of the Association. It is most useful to have these, and I am sure they will be of great use to municipal engineers who may be thinking of adopting the cable system. I believe I was the first municipal engineer who had to report to his authority upon the cable system, that was in 1882 or 1883, so that cables in this country are quite modern. The cable line at Highgate was, I believe, the first that was constructed in Europe. Now that line, as at first intended, was such that I felt bound to object to many things which the American engineers wished to put down in our streets; they would not at all suit the traffic or the convenience of persons in the country using the roads. Those plans were very

much modified, but finally were withdrawn, and a very much better set of plans were afterwards adopted. But coming to the North—to Edinburgh—I was very agreeably surprised to find that most of the difficulties in our system at Highgate, in fact nearly all of them, have been obviated. We find here that the area of iron in the road surface—I am now speaking from a surveyor's point of view—has been very much reduced. The width of the slot has also been reduced. Now, although that has been reduced in this city, and I believe at Birmingham and other cities, I may say that we have never had an accident or the slightest complaint from the slot at Highgate, which is wider than it is here or at Birmingham. I very much feared at first that we would have difficulties with the slot, but I find it has stood admirably. I may say that the line at Highgate, so far as construction and the quality of materials are concerned, could not have been better. Another point in the Highgate line is the pulleys; the arrangement of pulleys there is such that if they do not get very close attention they cause noise, and their continual buzzing is a great nuisance to persons living in the line of route, although it may not be observed by passers-by. In Edinburgh I scarcely notice any noise at all; even when listening over the pulleys you can scarcely hear anything. The system of lubricating the pulleys here is very much better than at Highgate, and, I am sure, Mr. Colam will be able to tell us, takes much less labour. With regard to Highgate financially, I have not the slightest doubt that the line would be a success if we could only get the traffic on week days that we get on Sundays. In Highgate we are just reversed to what they are in Edinburgh. In Edinburgh they get their traffic on week days. In Highgate I think five-sixths of the traffic is carried on Sunday, and with the same staff, the same number of cars, and I have no doubt with the same expense for fuel and engine power. So that if we had that traffic it would be a financial success.

Mr. Pritchard: I, first of all, must support the proposition that has been made in the vote of thanks that is carried to Mr. Cooper and Mr. Colam for the very instructive and, I consider, very ably prepared papers. I regret I was not sufficiently long in the room to hear the first paper read, but I feel satisfied that from what little I did hear that the whole paper may be taken as a good one, and I hope in the future the suggestion of our worthy president will be adopted, that the papers should be handed in in time for them to be perused before the discussion; especially

when papers are submitted of such importance as that bearing on the matter of sewage. It will give us a proper opportunity to fully appreciate an able paper such as the one we have had. There are two points in that paper to which I would like to ask your attention. The one is the highly praised and now abused Craigentinny, and the other is the paving. I saw the Craigentinny meadows many years ago. They show what can be done with the treatment of sewage through land. I believe it is said that sewage has been disposed of there for something like one hundred and fifty years. If so, it shows the wonderful capacity of the soil, because some few years ago I removed a portion of the surface grass, and six inches below the surface I found virgin soil, with not the slightest approach to any contamination by sewage whatever. Therefore if only dealt with by the aid of a few men, what must the meadows be if dealt with at about a hundredth part of the cost of some sewage farms in England? I have no doubt Mr. Cooper in further explanations will give us some reason why nothing has been done at the present time to make the appearance of the meadow a little more pleasant to the eye. Anyway the success has been great. With regard to the paving, I am, I think, now rather in sympathy with my friend Mr. Colam. I read in the *Scotsman* yesterday, from a special correspondent, something about one of the oldest Town Councillors of the city devoting his time in London to discovering the best modes of paving; and I notice there some remarkable information—information which I certainly was not in possession of before. I rather hesitate now to accept it, seeing it has to be verified. But I would like to point out this. Wood paving in its best form is a luxurious paving, but it has not the life that the writer of the *Scotsman* tells us it has. But I would certainly warn the authorities against attempting to pave the cable car lines with wood. We have had cases where, as Mr. Meade very carefully describes, there was a tendency to close. I have taken great interest for several years in connection with tramways, and in conjunction with my colleague, Mr. Kincaid, M. Inst. C.E., have had to advise for a large installation in Birmingham. I visited every city in America, excepting one, where there was a cable system laid, endeavouring to escape their mistakes, and if possible to adopt the very best system. We have done our best. All I can say, in reference to the Edinburgh roads—and I have had an opportunity of seeing them from the first very frequently—is that they are

really, for the money expended, very good roads. They are lighter than the Birmingham roads, and so far they have shown they are very well constructed. Mr. Colam has referred to me on two points which I would like, without taking up much time, to make allusion to. He refers to the hilly districts as being practically reduced to level plains. That is so. There is no known power of traction so economical as that of rope haulage. I have had experience of cable and steam, and now of electric, having just completed six miles of electric road driven by accumulators. He says the hilly districts are reduced to level roads. It has been said "You may work your hilly districts, because you compensate your roads, but if you get on to a level district you can do nothing." I saw in Chicago about twenty miles of road. That is a perfectly level plain. I afterwards stated, on my return to England, that I believed I should be able to haul, all expenses included, at about $5\frac{1}{2}d.$ per mile. That statement was simply ridiculed, but Mr. Colam has pointed this morning to the Birmingham road. I assure you it is coming very near it. In the Birmingham Company's published accounts for twelve months they give the cost per mile, inclusive of every expenditure, at $6\frac{1}{10}d.$ There is no other system where you can get that. The President referred to the comparison as to the Melbourne saving, and the payment of a big dividend. I also would have liked to have put a question to Mr. Colam upon that point. We know it is not the matter of dividend paid, but we want to know the basis upon which the dividend is declared. In Birmingham, for instance, the dividend is a very small one, but the money supplied by the cable route for the last twelve months gives 13,500*l.* available for dividend from three miles of route. As the cost of working cable tramways is very much the result of construction, further information is desirable. I do not know whether it is asking too much, or whether we ought to expect that, but if so, I should like Mr. Colam to give us the number of car miles run, with the expenditure; or, if he prefers it, the cost per mile for haulage, or the total cost per mile of working expenses; also the receipts per mile. Much depends on the clear statement of the points I have mentioned, when a comparison is made, as in the case of Birmingham, where during the last twelve months the cost of haulage has been very low, only 2·55 pence (slightly over $2\frac{1}{2}d.$) per car mile. In Edinburgh the population is not so dense as in Birmingham, but it would be interesting to know what the cost of traction

or haulage per mile is. There are many other points I would like to have alluded to, and I think, in justice to Mr. Colam, I must note one, and that is the gripper. There is no doubt it is an exceptionally clever invention. I think the company are very fortunate in having so able a gentleman in charge of so important an undertaking as the Edinburgh Cable Tramway.

Mr. C. Jones: I rise, not to continue the discussion, which has been most interesting, and would be still further so if we had more time; but I wish to draw attention to a point in connection with our friends, the Burgh Engineers of Scotland. I just put a question to our esteemed secretary as to the number of Burgh Engineers who are connected with our Association, and I find there are only about six; well, I am quite sure it need only come out through the press that the Borough Engineers of England take a deep interest in all that takes place in Scotland to lead a very large number of them to join the Association—an Association that takes such a deep interest in all municipal matters. I feel that the papers that have been read are such that they ought to be in the hands of every Burgh Engineer of Scotland. That desire can be accomplished by the receipt of the volumes which are issued by the Association. I do hope that we may in the course of a year find a report from our esteemed secretary to the effect that a very large number of the Burgh Engineers of Scotland have joined the Association of Municipal and Sanitary Engineers.

Mr. Lobley: I want permission to say a word on one point, and I shall not take up other points. On the last page of Mr. Cooper's valuable paper he alludes to the proposition to submit to the sanction of Parliament new regulations for the improvement of the spaces in front and at the rear of dwellings. As regards the front, the proposed increase of width is from 30 to 40 feet. He then goes on to allude to the open ground at the rear of buildings. This also is a very good provision. Most of us are working under bye-laws, something like the Model Bye-laws, about the space at the rear of houses—150 square feet of superficial area, with a distance across the space of 10 feet at rear of a building of one storey, 15 feet for two storeys, 20 feet for three storeys, and so on I believe I am correct in saying that Liverpool was the first to. inaugurate that bye-law. But the great fault is that the local authorities very frequently allow that bye-law to be infringed. It is almost a monthly occurrence to allow one-storey buildings to be erected for various purposes, such as greenhouses, coal-houses,

sculleries, and workshops. It is argued that so long as the 150 square feet is left, the other part of the regulation is of little importance. Sometimes a second storey is allowed to be built. Even, I believe, at the inquiry at Crewe, a Local Government Board Inspector, Dr. Thorne Thorne, said that after six months there was no power to prevent a person from adding a storey to his back wing. This however, has been rectified by the Public Health Amendment Act of this year. It still leaves the matter too much in the power of the Local Authority to permit these erections at the rear of dwellings. I should be very glad to see Edinburgh, or some other large city, starting an entirely radical change—something that would absolutely prevent any person or owner of property from even asking the consent of the local authority to put up a building in the back space. If the back street could be made 20 or 30 feet wide, it would absolutely prevent any one erecting buildings on it; the 150 feet area would be there in the private backyard, and the air space across would be absolutely safe from being built upon. I merely throw out these remarks for the consideration of members of this Association.

The PRESIDENT: I am afraid I shall have to close this discussion. If any other members desire to ask questions, if they would put them in writing, I am sure that Mr. Cooper and Mr. Colam would be very happy to answer them, so that we may have them in the Minutes of the Proceedings of the Association. I will now put the vote of thanks to Mr. Cooper and Mr. Colam.

The vote was carried with applause.

Mr. COOPER: I came before you with much diffidence, and threw myself upon your generosity; I knew there was plenty of it. In regard to the way in which I treated the secretary in not sending him my paper beforehand, it never occurred to me that it would be printed and circulated. But Burgh Engineers here all know how one's time is absolutely frittered away by small details, and the preparation of a paper, unless it is in the hands of our more capable and literary brethren, is not altogether a joke. I have to thank you for your forbearance in listening to me. I do not know that I need reply to much, except the question as to the Craigentinny Meadows. These meadows, of course, are in the hands of an owner, and he keeps the sewage and can do with it what he likes; he pours it on in unstinted measure, and the revenue is commensurate with the amount of the mineral property of the sewage. A large part of the fringe along the seaboard is pure

drift sand. The fringe has a slope to the sea. The meadows lie open to the sea, and the sewage passes off them, after being put on each plot for an hour where it has left the better part of its mineral property. The air in the sand having a recuperative effect, the land has never become blocked with sewage. I am very much obliged to Mr. Meade for his hints in regard to the disposal of refuse. I think that important. So long as we can get our refuse disposed of as we are doing, perhaps the cremating process may be delayed. This is a point we in Edinburgh are indebted to you for, for the light thrown upon the subject. With regard to Mr. Lobley's remarks about open spaces, I sympathise with him. In Scotland we have tenements—a thing which is only beginning in England. For these huge tenements we require more open ground than you do for lower houses. If our Dean of Guild Court should inaugurate the principle of providing ground proportioned to the height of the building, I think they will do wisely. Because our law at present provides that even for a one-storey cottage we require as much open space in rear as we do for a five-storey tenement with perhaps a score of families in it. That is an anomaly certainly. I can only thank you for your forbearance.

Mr. Colam: I have to thank you, Mr. President and Gentlemen, for the kind way in which you have received this paper. I am sure of this—it has given me a great deal more pleasure to bring it before you than it can possibly have given you to receive it. It has been my study for a very long time, and it has also been my particular wish to concentrate my knowledge on the subject in a paper before such a body as yourselves, who are really the people we have to deal with when it comes to the point. I would also like to reply to the President to make matters a little more explicit on the points on which he wishes information. As to what I meant when I said we had demonstrated in Edinburgh that systems of tramways in various parts of the city could be worked into one system by interchange—what I meant was this. Assuming you have a tramway being worked in the west end of the city by an engine-room which is in the west end, and an engine-room the power of which can only be carried to a certain distance, say to the centre of the city or any other part, you can also have another one working the east end of the city, extending the cable up to the very point where the other one from the west end leaves off. I have demonstrated in Edinburgh that this can be done, because I have one system at work in one portion of the city and I have another system in another, and at the

point where these two join there is a connection by an auxiliary cable, although they meet, as it were, round a corner. With regard to the other remark of the President, about the comparative results from horses and cables, I think I referred to that in my paper. I pointed out the results in Birmingham from the cable cars and the horse cars. It is not necessary for me to say that in taking these figures you must have a local knowledge of the place. You must know whether the horses are working under the same conditions as the cable cars. With regard to Mr. Meade's remarks, I am much obliged to him for what he has said. He has had perhaps more opportunities than any engineer present of going into my plans. He knows the construction here as compared with Highgate, and as compared with what was originally proposed by the American engineers when they first came. I shall have great pleasure in adopting the suggestion thrown out by Mr. Meade in providing the secretary with the blocks which are contained in my paper for the purpose of your 'Proceedings.' With regard to Mr. Pritchard's remarks, he says he has had some experience of the closing of the slots. I am very pleased to say we have not had that experience. But then our local authorities have not insisted upon wood. At the same time it has, I think, been demonstrated pretty clearly that we are getting woods now from Australia which may meet this difficulty.

Mr. Pritchard: Australian lines have closed.

Mr. Colam: But there is a reason for that. I think that the form of construction of the slot rail is wrong. It is one that lends itself to closing, and with all due deference to Mr. Pritchard the rail that is introduced into Birmingham also lends itself to closing, because it leans over on the side, out of the perpendicular, and any pressure which is being brought to bear laterally only tends to turn the rail about a point 6 inches below the surface of the road. With regard to the Chicago lines, I may say I have a letter from the president of the company, in which he says that he now finds the working expenses per car mile run on the cables to be 9½ cents, compared with 23 cents by horse previously. With regard to Melbourne I must say I never attempted to give any comparative information upon it, because I thought it was rather infringing upon the limit of my paper. But with all due deference to Mr. Pritchard I do not think it is of any use giving you information as to the cost per mile run. It is information that is in a way useful, but it is very misleading to those who are not possessed of a special

knowledge as to tramway work. The cost of running per car mile depends of course entirely upon the facilities for working. In Edinburgh, I think, we are working at 54 per cent. of our gross receipts, far below any other tramway in the country excepting Birmingham. Our expenses per car mile come out high, but at the same time we should be able to pay a dividend where companies working at the lower cost per mile would not; therefore I think it is misleading. You can give the cost of haulage as separate, and then you can give the cost per car mile under certain conditions. Therefore I contend that the hackneyed expression "What is the cost of running per car mile?" is altogether misleading. I do not think I have given the number of cable car miles. I have simply referred to the number of miles laid, and some few interesting points. If I had gone into the Melbourne system, there is no reason why I should not have gone into the Brooklyn, the Chicago and the San Francisco systems, which are doing very well. Therefore I think it was well to confine my remarks to such as I gave in the paper. I again thank you very much.

*On Thursday the 26th, after discussing the papers, the members were taken over the Cable Tramway lines, and visited the machinery depot, &c. They then proceeded to the City Chambers, where, in the absence of the Lord Provost, the Deputy Lord Provost and members of the Corporation received and entertained the party to luncheon. A visit was then paid to the Exhibition, where the members were recieved by the Executive Committee, and afterwards inspected the exhibits. In the evening the members were entertained to dinner by the Cable Tramways Corporation.*

*On Friday the 27th, a visit was paid to the Forth Bridge. The party was met at the Queensferry Station, north of the bridge, and conducted over the bridge on foot. They then embarked on a steamer, passed under the bridge and around the piers, back to the south side, and returned to Edinburgh by coach.*

# THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

The Statutory General Meeting of the Association was held at the Institution of Civil Engineers, 55, Great George Street, Westminster, at noon on Wednesday the 21st day of January, 1891.

The President, Mr. H. Percy Boulnois, M.Inst.C.E., occupied the Chair.

The Secretary read the notice convening the meeting.

The President: Gentlemen,—It gives me very great pleasure to meet you here as members of the Incorporated Association of Municipal and County Engineers on this occasion, marking, as it does, a new departure in the history of our Association. As Shakespeare says:—

> "There is a tide in the affairs of men,
> Which, taken at the flood, leads on to fortune."

And I take it that now that we are incorporated, and have a definite *locus standi* in the affairs of the country, we have as a body reached an important turning-point. I believe that this Association, which has grown from very small beginnings, will undertake yet more important work in the future. I congratulate myself, and you too, gentlemen, that Mr. Lewis Angell has kindly consented to read us a paper at this meeting, for you will see how very appropriate it is that he should do so when I remind you that Mr. Angell is the "Father" of this Association. I believe I am correct in saying that Mr. Angell was present at the meeting held in this very room some seventeen years ago [Mr. Angell: "Yes."] when he and a few others of the leading sanitarians of that day resolved upon the founding of the old Association, which has gradually spread and developed until it has become necessary to seek incorporation. It is trying that there should be so very small an attendance upon such an occasion as this, but there are a good many reasons for that. In the first place, I may very well claim that one reason is the confidence the members, as a body, have in the Council, for surely it shows their confidence that, on so very important an occasion as this in the history of the Associa-

tion, so few should be present. Secondly, this is a statutory meeting, one which must of necessity be held under the statute, and we all know that such meetings are not, as a rule, attractive to many. A third reason is the inconvenient day which has been chosen for the meeting, a Wednesday; and for this I am afraid I am to blame, as, owing to my engagements at Liverpool, I intimated to the Council, that, unless this day could be arranged for, I could not possibly be present during this week at this meeting. I will now call upon Mr. Cole, our Secretary, to read

## THE REPORT OF THE COUNCIL.

*To Members of the Association.*

Gentlemen,—We now bid adieu to the Association of Municipal and Sanitary Engineers and Surveyors, after its successful career of some seventeen years, during which time the work has been carried out in connection with the sanitary organisations of the country, which has left its impress upon the various departments of the community, from the country village to the great centres of metropolitan industry; and under the presidency of men of well-known positions in the sanitary world it has progressed from a comparatively small beginning to a position of recognised influence and importance. The time having now arrived in which the fresh developments of Parliamentary action in connection with the division of Municipal work amongst newly-formed bodies—County Councils and others—has led those who have had the management of the Association to take the necessary steps to bring about a more comprehensive body than could possibly have been the case under the regulations of the old Association.

And in introducing the Incorporated Association of Municipal and County Engineers at its first meeting, the Council desire briefly to put before the members a *resumé* of the steps taken, so as to be an official record of the inception of an undertaking which, it is hoped, will be of great importance in placing the Society on a more solid basis than hitherto has been the case.

Some four years since a good deal of attention was given to the question of applying for a Royal Charter, and a Minute in the Annual Report of the Council of July 1887, referred to the question of expense, besides "other considerable difficulties to be overcome," and that it was pointed out that registration under the Companies Acts would meet our requirements, and the Council were still considering the advisability of registering under these Acts pending

future action in reference to obtaining a Royal Charter. In the Report for the year 1889, we find the following clause:—"The Committee of the Council having very carefully considered the question of registering the Association under the Companies Act, and of the advantages that such incorporation would afford, especially in the matter of examinations, report strongly in favour of such a step being taken." The Council fully approved this report, and it was thereupon moved and carried, "That the Association be registered under the Companies Act," and a committee of five members was appointed with full power to carry the aforesaid resolution into effect. The Council reported in the following year that the committee appointed to take the necessary steps, after many meetings, finally settled upon the necessary memorandum and articles of association. These the Council adopted, and they were duly submitted to the Board of Trade. Amendments were made by the Board, which were in their turn reconsidered by the Committee, and the application was at last advertised in the *Times* of the 14th June.

Finally, the Certificate of Incorporation, dated the 22nd September 1890, was received on the 24th of the same month.

The process of change from the old Association to the new is effected by the signing a formal transfer of rights of membership. This form (Form F) has been sent, with a copy of the Articles of Association, to every member for signature. It may be interesting to note that up to the present 321 members have thus subscribed their names as now belonging to the new Association. It is hoped, however, that the full *rôle* of the old Association will, in a short time, be included.

It may also be here worthy of note, that, in sending in their forms, when members have taken the opportunity of commenting, the opinions have always been of unqualified approval of the step taken by the Council.

The first and most important alteration made in passing into the new body is the change in title. Many suggestions were fully discussed and put aside, finally resulting in a title embodying first the Municipal Engineers, which has always been the *raison d'ètre* of the Association, and secondly, the County, as including engineers holding appointments under recent Acts of Parliament, as well as to include the present County Surveyors. It was decided to drop the title "sanitary," and also the term surveyors, it being understood that the term "engineer" includes "surveyor." Finally the affix "Incorporated" has been inserted by special

desire of the Board of Trade. In the consideration of this matter, the Council have kept in view the desirability of shortening the somewhat cumbersome old title—and although much has not been actually achieved in this direction—the result is probably as short as is consistent with the necessities of the case.

With the object of increasing the Association's usefulness to its members, the Council recognises very fully the importance of encouraging candidates who pass the examination subsequently attaching themselves as graduates to the Association. It is felt that these gentlemen in this way have opportunities of gaining an immense amount of valuable practical information that cannot be acquired by any other means. The number of graduates who, upon their holding chief appointments have been transferred to the List of Members, is a significant fact as pointing to the advantages of the class, and with a view of inducing all those certificated candidates to join, the Council has reduced the annual subscription from one guinea to half of that sum.

The preparation of the Articles of Association has been done with the assistance and counsel of Mr. Pritchard, solicitor, of Messrs. Sharpe, Pritchard, and Co., the firm having had ample experience in the incorporation of other similar societies. Every clause has been under Mr. Pritchard's review and criticism, that gentleman having attended the meetings of the Committee, and has rendered that body every assistance in the consideration and final settlement of the whole matter.

In conclusion, the Council trust that the incorporation of the Association will have the desired effect of increasing the public confidence in the examinations, and the value of the certificate granted to successful candidates; that those who hold the certificate will be induced to join as graduates, deriving thereby an immense amount of useful knowledge and practical experience from their attending meetings and visiting works; and, lastly, it is hoped that the step taken, involving considerable expense and outlay of time and trouble, will be met by members exerting themselves to strengthen the Association by bringing in fresh members, and loyally helping, in every way possible, to make the newly incorporated body a continued and an increasing success, and a means of mutual help and of invaluable professional assistance in the important public positions they are called upon to occupy.

It was moved by Mr. T. Farrall, seconded by Mr. Mann, and carried, "That this Report be received and adopted."

Mr. Louis Angell then read the following paper:—

# MUNICIPAL WORK AND SANITARY PROGRESS.

By LEWIS ANGELL, M.Inst.C.E., F.R.I.B.A.,
Borough Engineer, West Ham,
Past President.

The incorporation of the "Association of Municipal and Sanitary Engineers and Surveyors" under its new title of the "Association of Municipal and County Engineers," constitutes an epoch in our history upon which I have been requested to address the members on the occasion of our first formal meeting under our new constitution.

We do not regard this as a new departure, but as an extension to include a new class of quasi-municipal officers, the County Surveyors, whom the development of local government has recently called into existence.

It is just twenty-one years since, in connection with the Royal Sanitary Commission, I ventured on a correspondence with the Government of the day upon the position of the Town Surveyor, arising out of which, in the following year, February 1871, I addressed a circular letter to the Town Surveyors of England and Wales, suggesting a conference and association. The response was general and unanimous. An informal meeting was held in my office in the Town Hall of West Ham, March 11, 1871. The attendance was small, but representative, and consisted of Mr. Jacob, the present Borough Engineer of Salford; the late Mr. Greatorex, Borough Engineer of Portsmouth; Mr. Monson, the now very active member of the Metropolitan Asylums Board; Mr. Jones, our present honorary secretary; and myself. Out of that small gathering our Association arose; and at its inaugural meeting at the Institution of Civil Engineers, Westminster, May 2, 1873, the honour was accorded me of being elected the first President, which is my apology for thus briefly referring to my personal connection with the work of the Association.

We are now in the eighteenth year of our existence. The

details of our birth, growth, and work will be found in the sixteen volumes of our 'Proceedings.' We have therefore a history, a literature, a "local habitation, and a name," and trust we have also justified our existence.

Membership of the Association being confined to the Chief Engineers and Surveyors of the Municipal, County, and Local Authorities, our numbers are necessarily limited, but widely representative, extending as we do over the United Kingdom and Colonies. Meeting frequently in local centres, and annually in general conference, we interchange our views, knowledge, and experience over a wide area, upon every possible subject within our departments affecting the public health, comfort, and convenience. Including our honorary members and graduates, we number nearly 450, among whom are the Chief Engineers of the capital cities of London, Edinburgh, Dublin, Paris, and Brussels, and of the great towns of the country; also the Surveyors of the Metropolitan and of the Urban and Rural Districts. Our new Incorporation also includes the Chief Surveyors of the newly-constituted County Councils. Our Association may therefore claim to be a national society of picked men.

We have also, alas! a death-roll—names which have done honour alike to Engineering and to our Association. Our early and good friend Lynde, late City Engineer of Manchester; the cultured Morant, late Borough Engineer of Leeds; the gentle Gordon, who after many years of good work on the Continent, associated himself with us on his return to official life in England, and subsequently succeeded our honorary member, Sir Joseph Bazalgette, as Engineer to the London County Council. The sudden loss of Gordon, so soon after his transfer from Leicester to London, was one which the metropolis can never appreciate, because it had not time to learn his worth; but those of us who knew him recognised, in addition to the amiable gentleness which secured our love, a reserve of force which commanded our respect—a combination of genius with an exceptionally painstaking application to detail, whereby he sacrificed himself a martyr to official work. His epitaph might have been—"Killed by an over-conscientious discharge of duty." Our Association, in which he took so much interest, mourns his premature loss. Other names will also occur, whose work, if less prominent, was well done in their day.

During the eighteen years of our existence we have individually done much wor and, in association, claim to have quietly but

surely influenced much progress. To review the whole field of Sanitary Science in relation to Municipal work would very greatly exceed the limits of this paper, nor do I know that I could say anything that would be new to our members, inasmuch as our experience is very much alike, varying in degree rather than in kind; but it may not be out of place, on this occasion, to put on record the general features of our official experience as Sanitary Engineers.

Practical Sanitary work is a new branch of Engineering, the application of a new science. We need not go back to Moses or Hippocrates; Sanitary laws are coeval with Nature, but it was not till the Victorian era that they have become understood. Although making rapid progress, their recognition is, however, far from complete.

In 1871 it was said by the Royal Sanitary Commission, "great is the *vis inertia* to be overcome, the repugnance to self-taxation, the practical distrust of science, and the number of persons interested in offending against sanitary laws, even amongst those who must constitute chiefly the local authorities to enforce them." What was thus said twenty years ago, remains largely true now. We have still to do battle with ignorance and cupidity, and some there still be who charge plagues and pestilence to Providence or occult causes beyond our ken, rather than to the wilful neglect of sanitary laws.

The progress of Sanitation has been an uphill fight, opposed by obstruction of every kind. It is only within our own day, thanks to such earnest and devoted pioneers as Chadwick, Rawlinson, Southwood Smith, Farr, Simon, Carpenter, Richardson, and a few others who have followed in their lead, that Preventive Medicine and Hygiene have been recognised and accepted under the new term of Sanitary Science, for which so much most excellent work has been done by the Medical Staff of the Local Government Board. Intermittent legislation, chiefly by local Acts and in small measures, occurred in the past to regulate some pressing necessities as from time to time they made themselves felt, but it was not until 1848, when the General Board of Health was constituted, that any practical attempt was made to deal comprehensively with the public health, and then only in a tentative and permissive manner. It was the Act of 1848 which called into existence the embryo of the Sanitary Engineer. Engineering knowledge and sanitary science had not previously been qualifi-

cations required in a Town Surveyor—an officer who sometimes combined the callings of house agent, auctioneer, builder, and undertaker, with that of Surveyor to the Local Board. Up to that time, and long after, so-called sanitary work was very unscientifically done.

The application of the first Public Health Act being permissive, the formation of a Local Board of Health was a voluntary matter, and many and fierce were the local fights thereon. As Sir Robert Rawlinson told us in the *Times* the other day, "the Act was unpopular to an extent hardly to be credited now," and that at some of his local inquiries, as Chief Superintending Inspector, he had "rowdyism more than enough." Such "rowdyism" has been the painful experience of many of our members, who have been subject to the tactics of the "jerry" building and "muckabite" representatives sent to the local authorities with a mandate of "how not to do it." The voluntary evidence tendered by the official surveyors of the country, printed in the first volume of our "Proceedings," is sufficient proof of the obstruction to sanitation by the public authorities of that day, as well as of the unenviable position of public officers. The local surveyor was himself regarded as a nuisance and received more kicks than half-pence. To the mere ratepayer, Sanitary Science meant officials, works, and taxation, an investment returning no dividend, no account being taken of the value of health and comfort, nor of the loss and taxation consequent on disease and pauperism.

In all the sanitary fight the Town Surveyor has had a hard time. His is the best abused of all public positions, he is the constant subject of criticism as the spending and administrative officer, he is always *en evidence*, his duties bring him into constant antagonism with a large number of interested people whose underground means of retaliation are not always apparent in the plausible attack professedly made in the public interest. Honest criticism is wholesome, it enables us "to see ourselves as others see us"—a stimulus to flagging duty—but most of the advice we receive so plentifully and gratuitously is the outcome of mere flippant and aggressive ignorance. Officers do not come of a distinct caste—we are men of like passions with the rest, neither worse nor better, but having the advantage of experience and sense of responsibility. We once raised the cry of Protection. Protection is dead. The Local Government Board, our natural protectors, have never helped us. They hold their inquiries, they

impose their obligations, they favour us with their criticisms, but in no single thing have they ever assisted us. Fortunately we have learned to do without them.

Local Government is a great institution—the palladium of our freedom, the bulwark of our liberties, the safety-valve of the Constitution—such it is in theory and in fact; but, as a practical comment thereon, almost every local paper reports "disgraceful scenes," "scandals," "personalities," neglect of obligations, and worse, of our local governors. Sceptics inquire "whether or not Local Government is a fraud?" Where such things are, there must indeed be "something rotten in the State."

Things are done differently, if not better, in France. Only last week we read of the death of Baron Haussmann, the reconstructor of Paris. In 1853 Napoleon III. discovered Haussmann at Bordeaux, and made him Prefect of Paris. Haussmann in turn sent for his engineer friend M. Alphand, our honorary member, also then of Bordeaux, and together they transformed Paris. In subterranean Paris they constructed a magnificent system of sewers, traversed by tramways, which, if differing from our own practice, has preserved the city comparatively unharmed through three cholera epidemics. Above ground, Paris was converted into a city of splendour—the pride of France, the delight of the English, and the heaven of the Americans. Under the Empire the local government of Paris was a triumvirate of the Emperor, the Prefect, and the Engineer, compared with which the Vestrydom of London is as the sublime to the ridiculous. "A thing of beauty is a joy for ever," which we can hardly apply to the results of Local Government in England. If one may be allowed to parody a famous ecclesiastical dictum, England would rather be free than beautiful. But there are some among us "with soul so dead" as to prefer an intelligent despotism—government by an Ædile.

There is no reason why Local Government should be a fraud; it is based on the theory that representative men of intelligence, business ability, capacity, and disinterested motives shall constitute the governing body, not selected from any one class, but of any class possessing the due capacity. But in practice local affairs are too frequently avoided by those most fitted to take part therein. Local power and patronage are objects of small ambition to persons of mediocre ability, and the position has been frequently sought from personal and interested motives. Under such influences Local Government degenerates into littleness and inefficiency in the hands

of uninformed, interested, and prejudiced persons, to the exclusion of intelligence and sound judgment. In 1871 the Royal Sanitary Commission reported "that no code of laws, however complete in theory, upon a matter of such importance and complexity as the health of the community, can be expected to attain its object unless men of superior education and intelligence throughout the country feel it their duty to come forward and take part in its working. The system of self-government, of which we are so justly proud, can hardly be applied with success to any subject unless the governing bodies comprise a fair proportion of enlightened and well-informed minds." Has there been any improvement in this respect since 1871? Whenever there is an epidemic scare or a snowstorm, it is the fashion of superior people, utterly careless at other times as to their local institutions and representation, to launch out into hysterical denunciations of local management and public officials. Such persons would do far better service by taking their proper part in the local government with which they think it *infra dig.* to associate themselves.

The middle class—the intelligence, business ability, the leisure, and the wealth—have had their opportunity and failed; they have neglected their obligations and responsibilities. Under the new *régime* their influence is passing away. The masses have learned their power, are becoming alive to their own interests, and will govern. With "one man one vote" one man is as good as another, and, as Napoleon said, "Victory is on the side of the large battalions." The masses have all to gain and nothing to lose; and, for good or for evil, they will rule the future, wisely, let us hope, but, as in the past, many successive idols will be set up and destroyed ere the millennium. Salvation will be in education, in which England is so much in arrear. Amid all the din and claptrap of the platform oratory of the day upon questions of social economics by which the people are being "fooled to the top of their bent," two subjects lie at the root of all comfort and progress—education and sanitation—the sound mind in the sound body. Ignorance is the greatest obstacle. Education is a birthright, and should be free. Sanitation should be free, that is to say, the best public sanitation should be provided at the public cost—which is the intention of the law—and it should be equally obligatory that all private or domestic sanitation should be provided by those responsible, be they landlord or tenant, and the means being provided, their use and observance should be made as com-

pulsory as is practicable by enforcing the legal maxim that ignorance is no defence; then, indeed, should we have the schoolmaster abroad. Sanitation, Education, and Thrift would accomplish more for the people than all the will-o'-the-wisp delusions of political panaceas.

But to return to the history of Sanitation. In 1858 the General Board of Health was abolished and its functions transferred to "one of Her Majesty's principal Secretaries of State." In 1875 the Local Government Board was constituted, and the numerous amending Acts which succeeded the original Act of 1848 were consolidated and made compulsory instead of remaining discretionary as previously, and such has been the advance of public opinion that even the local authorities have obtained Acts to supply the *lacunæ* in the Public Health Acts; some were even too fast for the Government, obstruction being encountered where encouragement had been expected. Twice had the Borough of West Ham to apply to Parliament before it could wrest an Act giving power to appoint Building Inspectors and charge them, as in the Metropolis, to the proper account—the builders' profits; a measure which has since been copied by other towns. Daily experience still shows many defects in the Public Health Acts, and that much amendment is necessary.

In 1888 we arrived at the climax of the principle of Local Government—its extension to Counties, whereby the "great unpaid" were practically disestablished. No portion of the country, be it city, village, or hamlet, is now without popular representation in local management, and, notwithstanding many defects, very ample machinery is provided for the universal development of sanitary work. The Sanitary Engineer has been established and endowed—that is to say, the office has become a necessary one, and sufficient, if not liberal, inducements offered to secure capable officers.

For a long time the Town Surveyor also combined the functions of the Sanitary Inspector and Medical Officer, so far as such functions *were* performed. These offices now exist collaterally, each working in its own proper province and i unison. Reference has already been made to the crude and unsatisfactory work of the past, when neither the professional status, remuneration, nor treatment were such as to secure or retain efficient service. The development of Sanitary principles required competent exponents. A leading object of the founders of our Association was to bring

about an improvement in this respect. One of the articles set forth in our Incorporation is—

> "The promotion of the professional interests, rights, powers, and privileges of county, urban, and rural engineers, the improvement of their professional status, and the extension and interchange of professional knowledge and practice."

Another of our objects is—

> "The examination of persons in engineering, surveying, building construction, sanitary science and works, and in local government, municipal and sanitary law."

The question of the qualifications of public officers has been much discussed. The Medical Officer has to prove by examination that he possesses at least a minimum of qualification, and by a parity of reasoning the Engineer should also be required to prove his capability.

In the matter of examination our Association has come into some conflict with a junior Association, the Sanitary Institute, a body which has done good work in promoting a public interest in sanitation, and whose proper field is education; but we considered it our duty to oppose their action in seeking, by Royal Charter, the right to examine us. Our Association is strictly professional and official, whereas the Sanitary Institute is a heterogeneous society open to all comers. We do not object to examination in principle, but we repudiate the claim of such a body as the Sanitary Institute to be our examiners. We claim to know more about these matters than the Sanitary Institute, and if such examinations are to be conducted by a private society we claim to be the better examiners. If it be said that we claim to examine ourselves, we reply that our examinations were established as a protest against the Sanitary Institute usurping the position, but that public confidence would be better satisfied with the *testamur* of some qualified body legally constituted for the purpose. We have the Institution of Civil Engineers and the Royal Institute of British Architects, chartered bodies representing and having the confidence of the profession; or the Universities; or the Civil Service Commissioners. In or from these, or some of them, a representative Board of Examiners might be constituted. It is of the highest importance that responsible Sanitary Officers should have a thorough knowledge of Sanitary science, but also of practical work. A very young and inexperienced man may obtain a cram diploma, but the practical experience of an Engineer cannot be obtained by book work. The

genius of Invention, Art, or Science, cannot be hedged round by examinations. George Stephenson never passed any examination. In such matters diplomas may have a fictitious value, to the detriment of real worth. Nevertheless, if by examination we can eliminate quacks, we do not object to such a test being applied to candidates for local office, indeed, we would gladly extend it also to our local governors.

During the last few years, with the extension of legislation and better appreciation of Sanitary work, the position of the Municipal Engineer has greatly improved. Speaking generally, the officers of the larger towns, and proportionately of the smaller, have not now much reason to complain as to either status or remuneration. The Association has congratulated itself on this result, but recently there has been a retrograde movement. It was the general opinion of the profession that London did not attach to the office of its Chief Engineer sufficiently liberal conditions, having regard either to its importance and responsibility or in comparison with other official positions. Unfortunately, the bad example, as always, was immediately followed by the second city of the Empire—Liverpool, the conditions of which recent appointment, and the reduction of the previous salary by *one-third*, is a deliberate case of professional sweating. As a matter of fact, towns of less magnitude offer much better conditions, and, as a matter of comparison, whether of rateable value, population, or importance, the anomaly is still more conspicuous. Liverpool was unjust to the profession, and its example has seriously damaged the interests of appointments of the first rank. The Municipal Engineer is the personation of the very object of the existence of the Corporation, viz. Works, but at the disadvantage of representing the spending department, which produces no profit, excepting in health and comfort—matters not appreciated till lost. The Engineers of Docks, Railways, Gas and Waterworks, in fact the Engineers of all such quasi-public and of private works, receive better consideration and the happy immunity from the very many petty worries of public office. These private Engineers generally represent interests adverse to the ratepayers, therefore the Municipal Engineer should be in a position to meet them on something like the same level, professionally and socially, otherwise it may be to the disadvantage of his town. Public office, at the best, is very harassing to a sensitive and high-spirited man, and consequently avoided by many of the best qualified; therefore, unless sufficient inducement be offered, efficient

service will not be secured. If the public service is to be put up to auction for the lowest bidder, candidates will be more numerous than select. It is not, however, suggested that the first two cities of the Empire are not, at present, well served in their engineering staff. Our Association has the honour of being represented in these two appointments by gentlemen of known ability, which only accentuates the argument. It is sweating. The levelling down of salaries will result in an all-round decadence of official service, and divert capacity into other channels where it is better appreciated.

It is a great temptation to an unprotected officer, especially if underpaid, to become a time-server, to ingratiate himself with the dominant party of the moment, or at least to shut his eyes, ears, and mouth so as to avoid offence; but it has been aptly said that "the man who makes no enemies usually makes nothing at all." With an ever-changing body a "strong" permanent public officer may accomplish much by self-reliance and consistency. In the long run he will find himself appreciated and his efforts successful.

The development of town sanitation has been marked by many vicissitudes. In the matter of sewerage it has been even amusing. At first it was penal to discharge house drainage or other offensive matters into sewers. It was laid down by a Lord Chief Justice "that every man should keep his dirt to himself"; then it became compulsory to drain into sewers, and during the first six years of the existence of the Metropolitan Commission, some 30,000 cesspools were abolished and their contents turned into the badly designed and badly constructed sewers of the day, thereby converting them into "elongated cesspools," overflowing into rivers which were the source of domestic water supply. The rivers being thus converted into main sewers, the Common Law was appealed to, and new laws made to prevent their pollution. How to dispose of our sewage then became the vexed question. Royal Commissions told us that to take it to the land would provide the people with food and make the nation's fortune. The result was disappointing, and, financially, a failure. Then came the turn of the chemists, the patentees, and the stock-jobbers—all failures, commercially. Finally, the Destructor is to settle the question, for which we have the precedent of the Gehenna, or Hell-fire, in which the filth of Jerusalem was burnt daily in the Valley of Hinnom. Thus has the sewage problem been shuttlecocked from pillar to post, and we

are left under the statutory obligation to adopt "the best-known practicable process."

Then, again, has been our battle with the plumber. All the details of domestic sanitary work were wrongly constructed; the cisterns, the closets, the sinks, the baths, the traps, the overflows, the drains, and the ventilation, all wrong. The house drains were so many services by which sewer gas was laid on to poison the air and the water. The Plumbers' Company have now recognised these facts and promote examinations and registration of workmen. In new houses we prevent all this by the modern building bye-laws, but hundreds of thousands of old houses remain under the above insanitary conditions.

Two unsolved problems remain—the ventilation of sewers and the disposal of sewage—questions which have been so much discussed in our sectional and general meetings, that no further reference will be made thereto.

There are very many other important matters, both Urban and Rural, coming within the manifold functions of the Municipal Engineer, to which no reference has been made. Attention has been confined to public sanitation as the pre-eminent feature of our work, in which we are presumed to be specialists.

To sum up a somewhat discursive paper, it may now be fairly claimed that the result of hygienic and engineering experience enables us to enter the last decade of the Nineteenth Century, late enough it is true, with a very full knowledge of sound principles for practical application to municipal sanitary work. We know what can be accomplished by prevention. The recurring plagues and epidemics of the past have been stamped out. Zymotic or "filth diseases" have been controlled, as proved by the steady and continuous diminution of sickness and lowering of the death rate, with the consequent money gain to the nation and happiness to the family by the preservation of life, especially of the wage-earners and bread-winners. Adulteration, housing, overcrowding, open spaces, hospitals, scavenging, drainage, in fact every vital question has been discussed, legislated upon, and right principles established. Since 1871 forty-three millions have been borrowed with the sanction of the Government for municipal, chiefly sanitary, work. We are not yet prepared to "rest and be thankful," but believe we know our way. What we now require is action. We must look to education rather than officialism to push forward the work, by the teaching in our schools—Greek, if you please—but social, natural,

and sanitary science, and by the creation of an intelligent appreciation of the fact that health is the greatest blessing of all, so to react on the public authorities as to compel sanitary progress; the responsibility lies with them, not with their officers. The existence of our Association, these eighteen years past, is a proof that we have been alive to our duties, and willing and anxious to help.

## DISCUSSION.

The PRESIDENT: I am sure you will agree with me, gentlemen, that we are greatly indebted to Mr. Angell for the paper he has just read to us, and I have very great pleasure in moving from the Chair "That a hearty vote of thanks be accorded to Mr. Lewis Angell for his paper." I am afraid that this meeting would have resembled the play of *Hamlet* with the ghost omitted, had not Mr. Angell been so good as to prepare the paper to which we have all listened with so much interest; it is one of great value to each of us, and also to all sanitary authorities. There is, of course, a great deal of discussable matter in the paper, but I do not know if it would be quite in order to discuss it now. Perhaps, under the circumstances, it would be best to deal with it as we should with a Presidential Address. But there are, however, one or two points on which I should like to say a word or two myself, if you will kindly permit me to do so. Mr. Angell has brought a very heavy indictment against local authorities, and I am bound to say that it is to some extent justified. Still, taking the Municipal Authorities generally throughout the country, Mr. Angell must admit that there is a great, a very considerable, difference between the present condition of local government and its state some years since, and upon the Darwinian theory of evolution we must expect that there will be in the future a still further improvement in such local bodies. Now just a word as to the Sanitary Institute. I am, as most of those present are aware, a Fellow of that Institute, and am also one of its examiners. The reason why the Sanitary Institute has held its examinations for surveyors has been simply that the Institute was the first to start such a movement. I have always held that that Institute was not the right body to conduct such examinations, and personally I have always declined to sit on a board examining surveyors. It is satisfactory to me to be able to add that I believe that the surveyors' examinations are gradually diminishing, for not many

surveyors now present themselves for its diplomas; but there is no doubt that the Institute is the proper body to conduct examinations of sanitary inspectors, and these continue to come forward for examination in considerable numbers. Another matter I must allude to is with regard to the salaries paid to officers in large cities. Mr. Angell has referred to recent appointments made by the Muncipal Authorities of London and Liverpool. Mr. Angell is perfectly right in his contention that it is a great misfortune that important corporations should underpay their officials. I think I ought to explain, with regard to Liverpool and myself, that when I first went in for that appointment nothing had been said about salary, and I had committed myself so far that I was practically unable to withdraw, when, as Mr. Angell says, it was resolved to reduce the salary offered, from 1200*l.* a year, the amount received by my predecessor, to 850*l.* a year. But, not content with that, the Liverpool Corporation practically put on a tax of 5 per cent. upon all recent salaries, by compelling their officers to leave in their hands that proportion of their salaries towards a superannuation fund, when at the present time there is no power on earth can compel them to pay out a penny of what they have taken in, should they choose so to act; and although they now talk of promoting an Act of Parliament to remedy such an extraordinary state of things, they show but little enthusiasm towards effecting a change in such an evident piece of injustice. A great contrast to a corporation is the action of a private trading body. For instance, there is the Mersey Docks and Harbour Board, who pay their engineer 4500*l.* a year; that shows the difference between a municipal official and one working for a private firm, or, as in this case, a trading body; and such a case confirms what Mr. Angell has said. I have now very great pleasure in moving that we give Mr. Angell a hearty vote of thanks for his paper.

The Honorary Secretary: As an old coadjutor of Mr. Angell, I can entirely sympathise with him in many of the remarks that he has made. Many of the points raised in his paper are exceedingly interesting and well worked out, and I am sure there is no disparagement intended to the individual officials who have accepted appointments under the conditions named. Some points in that paper are well worthy of consideration by us, and while it may be as well perhaps for us not to discuss them here, I trust the Council will permit them to appear, just as they are read, in our

'Proceedings.' There will be this advantage about it that an engineer might without offence ask a member of his authority just to run his eye down such-and-such a page of his Association's 'Transactions'; members of corporations would thus have the opportunity of seeing themselves as others see them. We have been told that the candidates for the surveyors' examination of the Sanitary Institute have been falling off, and I am somewhat pleased that this has come about spontaneously, for there is no desire on our part to appear antagonistic to any body of its class. Both working as we are for the good of the community, and standing so far apart, there is no need for any antagonism between this Association and the Institute. I have been brought into contact with the Sanitary Institute by lecturing for them, and I feel that it is doing a good work. The field is broad, as you know, and therefore it is well that we should go hand in hand with the Sanitary Institute in endeavouring to raise the tone and character of everything that has to do with sanitary work. With respect to the paper we have just heard, I can only heartily second the vote of thanks to Mr. Angell.

The President: The motion before us is "that a most hearty vote of thanks be passed to Mr. Angell for his paper."

The motion was carried by acclamation.

Mr. Angell: Mr. President and gentlemen,—I thank you very much indeed for the kind way you have received this paper. I know that my remarks have been somewhat trenchant, and I should not object to have them discussed. I have put it together, as you have seen, on slips of paper, as the ideas occurred to me during odd moments. I quite agree with our President that there is improvement, also a movement which is coming from below into our authorities which will cause some change; I refer to the introduction into Town Councils of labour representatives. My experience has been a long one; for some thirty-two years I have been a chief official, and some of that experience has been very rough—indeed, exceedingly rough at times—nevertheless, I have been, I may suppose, a successful man. A short time ago there were some members elected upon my Council who were bitterly opposed to me; I offended the jerry builders; in fact, one, a "Ratepayers' Association" man, has since told me that when he came on he and his party were "going for me," but, I am happy to say, that, as a result of seeing how much work there is and how it is done, they are now among my best friends and supporters. With regard

to the Sanitary Institute, I am a Fellow of that body of ten years' standing; I go with them in every possible way as an educational body, and I hope that before long the old friction between the Institute and this Association will cease. With regard to the Liverpool Corporation and their engineer, our President, I wish to explain that I intended no personal reflection in dealing with an abstract question of remuneration, feeling that it was not the way in which the second city of the Empire should pay its chief officials, and that its action was setting a bad example to other municipalities. I again thank the Association for their expression of good feeling.

# DISTRICT MEETING AT CHELTENHAM.

**May 9th, 1891.**

*Held in the Council Chamber of the Municipal Offices, Cheltenham.*

T. De Courcy Meade, Vice-President, *in the Chair.*

Mr. Joseph Hall was re-elected Honorary Secretary for the ensuing year.

The following papers were then read and discussed :—

## PUBLIC WORKS OF CHELTENHAM.

By JOSEPH HALL, A.M.Inst.C.E., Borough Surveyor.

On the 21st October, 1875, one of the earliest District Meetings of this Association was held in this room, and a paper on the Sanitary Development of Cheltenham was read by Mr. D. I. Humphris, Borough Surveyor. I propose now to carry on the story, showing what has been done during the fifteen years which have elapsed. The Chapter of Incorporation was granted in 1876.

### Sewage Farms.

Two additional farms have been purchased and laid out for irrigation, making a total area of 560 acres belonging to the Corporation, and a varying quantity of land along the line of the outfall sewer is irrigated at a charge of 8*s*. per acre.

The tanks are merely catchpits, in which the solids are deposited. The liquid flows away to the land; the mud is pumped

out by chain pumps actuated by a turbine, the motive power of which is the flowing sewage.

### Destructor.

Adjoining the sewage works a field has been purchased, and a destructor, with eight cells and two Jones's cremators, is being built by Messrs. Manlove, Alliott, and Co., and plans are being prepared for a central electric lighting station, with siding accommodation from the Midland railway.

### Waterworks.

The waterworks undertaking was purchased in 1878 for the sum of 217,664*l*. 6*s*. 1*d*., and in 1887 a new reservoir was constructed at Dowdeswell, under the direction of the late J. F. La T. Bateman, Esq., F.R.S., having a capacity of 100,000,000 gallons.

The filtration works consist of five sand filters, each 300 super. yards, with covered storage for 741,806 gallons of filtered water. The sand is washed in machines (designed by Mr. W. McLandsborough, M.I.C.E., the late Water Engineer), the motive power being obtained from a turbine driven by the water flowing into the filter beds from the reservoir.

The average daily consumption of water is about 650,000 gallons, and at the present time the springs are yielding about 738,824 gallons per day.

The construction of the reservoir is of interest as a recent work in which the comparatively discarded practice of laying the outlet pipe under the embankment has been adopted. This was no doubt done to avoid the serious risk of cutting or tunnelling through the lias clay which forms the side of the reservoir, the capacity of which for slipping may be judged by the state of the railway embankment near.

The water is derived from springs in the Inferior Oolite, which rests upon the lias clay, and forms the Cotswolds, a small portion dipping to the Chelt Valley and forming part of the watershed of the Severn, the larger part dipping and forming part of the watershed of the Thames.

In addition to this supply, the Corporation take water from the Severn at Tewkesbury, and have power to take about 3,000,000 gallons per day for distribution throughout their area of supply,

which is upwards of 38,625 acres, and includes the parishes of Ashchurch, Walton Cardiff, Tredington, Stoke Orchard, Elmstone, Hardwick, Deerhurst, The Leigh, Boddington, Norton, Staverton, Down Hatherley, Up Hatherley, Twigworth, Badgworth, Shurdington.

Recently a Deacon meter has been fixed at Tewkesbury, so as to measure the waste, and it has reduced the night consumption in a remarkable manner, the quantity diminishing as soon as it became known that the meter was fixed, and before any leakage was discovered.

Numerous street improvements have been carried out; 13 acres have been purchased for the purpose of extending the Cemetery, intramurial burials having all but ceased; 34½ acres of land have been purchased under the Allotments Act; the Pittville Gardens, pump-room, wells, &c., have passed into the hands of the Corporation, and are now being re-arranged and improved, with a view to render them more attactive. Although at present they must be considered as promises rather than performances, in the same category is the Promenade improvement, a portion of which is shown upon the wall, and the scheme for preventing flooding along the line of the Chelt. The Chelt has, like most small streams flowing through towns, been gradually encroached upon, until the channel became too small to carry off storm waters, and those parts of the town in the immediate neighbourhood of the stream suffered considerably. For upwards of twenty years the question has been discussed, numbers of reports proposing remedies have been presented, and small palliative measures have been from time to time adopted, amongst the latest of which was a scheme by Messrs. Bailey Denton and Co., proposing to form an entirely new culvert, varying from 3 feet 6 inches to 5 feet in diameter, and at an estimated cost of upwards of 10,000*l*., and this was under consideration when the Author was appointed last year, and he was instructed to examine the question and report upon it at as early a date as possible. After a most careful investigation he felt compelled to report adversely to any separate culvert, although recommended by so distinguished an authority as Mr. Bailey Denton, and supported by the late Surveyor.

The scheme proposed is to form a new invert of concrete of such size as will pass the largest quantity of water that can reach the culvert, and the side slopes at such angles as will render them self-cleansing. The cost will be about 3500*l*.

The advantages claimed are—greater waterway, less liability to obstruction, less interference with property and streets, probably fewer difficulties with gas and water mains, and—most potent reason—less cost. The Council had hoped to be able to obtain powers under a Provisional Order, but the Local Government Board declined to grant one, and have intimated that the procedure must be by Bill.

### Roads.

The roads and streets are almost exclusively macadamised, the stones used being Clee Hill stone, costing 10*s.* 10*d.* per ton broken ready for delivery; Wickwar costing 7*s.* 4*d.* per ton; and, for roads of very small traffic, a local Oolite from Leckhampton Hill. Recently a short length of tarred macadam has been put down as a specimen, the author being convinced that it possesses all the advantages of a macadamised road, with very few of its objections. In this case the system is at some disadvantage, as the foundations had recently been much cut up by gas, water, and sewer trenches, which will probably cause some settlements.

### Footways.

The pavements are almost exclusively of Forest stone, at a cost of 5*s.* 3*d.* per square yard, with some small portions of tar and gravel, costing about 2*s.* 3*d.* per yard. Last year a small piece of concrete pavement was laid by the Granolithic Company, and this winter a similar piece was laid by the ordinary staff.

The result of the efforts of the Council is to be seen in the diminished mortality, which in 1875 was 17·9, and this year is only 15·83, and in this direction further work is being done. Wells are being closed, and the water supply extended; the sewers are being examined, and all defects as they are discovered are being remedied. The ventilation is very limited in extent, and scarcely in accordance with present ideas; the Health Committee are therefore addressing themselves to, and have instructed the author to report fully upon, the question.

### Progress.

Although recent years have not seen in Cheltenham the same rapidity of growth which has characterised many other towns, yet

they have seen changes of scarcely less important character; from being a fashionable spa, depending on visitors solely, it has become one of the first educational centres in England, and a desirable residential town. With the reviving interest in English spas, and proper attention paid to render the town bright and attractive, there is no reason why Cheltenham, with its variety of waters—some of which equal, if they do not surpass, those of any Continental spa—should not again take its place, as of old, as the premier inland watering place in Europe.

# TAR MACADAM.

By JOSEPH HALL, A.M.Inst.C.E., Borough Surveyor, Cheltenham.

Very early in the history of macadamised roads their defects were noted, and many attempts were made to remedy them; amongst other means coal-tar was used for the purpose of binding the stones and rendering the surface impervious to water, but most of the first experiments ended in a comparative failure. After being generally allowed to die out, the question has for a few years been growing and gaining attention. Through the energy, care, and attention of a few men, principally members of this Association, tar macadam roads are now so well made, and are such a marked improvement over ordinary road surface, that no apology should be needed for introducing the subject.

In October 1889, the author sent out a circular, and in response received replies from 207 towns and districts, in 71 of which tar macadam is used to some extent, and 136 have no experience. Of the 71 who have experience, 55 give the most unqualified approval and strongly advocate its use, 10 give a qualified approval, 6 disapprove; and generally it may be stated that the wider and longer the experience, the more sweeping the advocacy.

The earliest systematic treatment was—select dry stone, pour over it so much cold tar as would ensure every stone being covered, turning over the lump at the end of six weeks, and if any stones were not covered adding tar. After a further period of not less than six weeks the heap was again turned, and was then ready for spreading. Small stone or shingle, such as would pass through a ¾-inch mesh, was prepared in a similar manner and used for top coating. Only light rollers were used, and the result fairly good if the work was done in fine weather; but if done during wet the effect was diastrous, and probably accounts to some extent for the neglect into which tar macadam has fallen. At another later date lime was added, and under some conditions is so far useful that in two or three towns it is still used for roadways, and largely for

footways. (A very good system for footways is described in Vol. XI., Proc. Assoc. M. and S. E. The surface is good, pleasant to look at and walk upon, the cost—1*s.* 6*d.* per yard—moderate, the life 12 to 20 years. The same proportions have been used for crossings, but with one-third part of 2-inch gauge broken limestone, which wears well; the only objection is that the traffic must be diverted for at least 14 days, and in dull damp weather for a still longer period.)

The tendency of recent practice appears to be in the direction of prolonged preparation, greater care in the manipulation, and the disuse of raw tar.

The best work is made by the mixture of pitch, creosote, and tar, boiled together and poured over hot dry stone in such quantity as will just coat each piece. The various gauges of $2\frac{1}{2}$ inches, $1\frac{1}{2}$ inches, and $\frac{3}{4}$ inch, are prepared separately, and used in the same order, the thickness of the coats varying according to the amount of traffic expected. At Leicester the ordinary thicknesses are 3 inches of $2\frac{1}{2}$-inch gauge, 2 inches of $1\frac{1}{2}$-inch gauge, and 1 inch of $\frac{3}{4}$-inch gauge, and the surface covered with cinder-dust, and this may be taken as the best proportion for ordinary traffic.

The large number of towns in which only pitch and tar are used show that it is possible to omit the creosote and yet make good work.

To attempt to give any proportion of pitch and tar would be misleading, but it may be noted that the quantities actually used vary from 8 gallons of tar to 1 cwt. of pitch as the extreme limit of pitch, to 224 gallons of tar to 1 cwt. of pitch as the extreme limit of tar, when any pitch is used.

The proportions at Leicester are 12 gallons of tar, $\frac{1}{2}$ cwt. of pitch, 9 gallons creosote, to 1 ton of stone. At Liverpool $\frac{144}{1000}$ ton stone $\frac{41}{1000}$ ton pitch, and $1\frac{1}{5}$ gallon creosote oil. Buxton, 36 gallons tar, 1 cwt. pitch, to 1 yard stone. Exeter, 8 gallons tar, 1 cwt. pitch. Great Grimsby, $\frac{1}{4}$ pitch, $\frac{3}{4}$ tar. Saltburn, 10 gallons tar, $\frac{1}{2}$ cwt. pitch, 1 ton stone. Sevenoaks, $\frac{3}{4}$ lb. pitch to 1 gallon tar.

This wide variation of practice may be accounted for, to some extent, by the qualities of pitch and tar varying at different times and from various places. To avoid the difficulty some have discarded tar entirely, and use only pitch and creosote; whilst of 71, 33 use only tar. But the best work appears to be made by the use of about 12 gallons of tar, 2 gallons creosote, and $\frac{1}{2}$ cwt. of pitch,

boiled together until bubbles rise to the surface and when bursting emit a puff of brown smoke. The best state can only be found by experiment.

With regard to drying the stone, the best practice and the most general is to heat the stone to such a temperature as will thoroughly dry it without in any way burning or otherwise injuring it, and adding the tar mixture before the stone cools.

Out of 71 towns, 20 only protect the stone after adding tar, by placing it under a shed. Observation of the work does not show any advantage of results, all that seems to be necessary is to stack the stone in a heap so as to heep out the rain as much as possible.

Upon the question of putting down the stone in layers there is very little difference of opinion, the consensus being that better consolidation is obtained thereby, and generally, for the same reason, a steam roller is preferred to hand or horse roller.

The stones used vary very widely. Granite, basalt, mountain limestone, Kentish rag, and blast-furnace slag, all having been successfully used, but generally the preference is given to limestone, as wearing most evenly, although, for any other than level roads, it is somewhat too smooth, and therefore slippery; to remedy this it is desirable to use in the top coat a layer of very small flint, basalt, or granite, which could be renewed from time to time by scattering upon the surface.

The interstices between the stones being filled with pitch and tar, no water can pass through, and all rain, &c., must pass over the surface, thus permitting the cross-section to be made much flatter than is usual. The side slope being less, carts and carriages will be drawn with less effort, and the horses will therefore cause less wear; there will be little or no sliding, a prolific source of wear in wet weather. The excessive barrel given to roads has a tendency to cause the traffic to keep in the centre of the road, the horse finding there the least exertion, with the result that the traffic is concentrated upon that portion of the road, and all other parts are left.

To some extent this will probably account for the discrepancy in the estimates of durability, which vary from equal to ordinary macadam up to a gain of 500 per cent. It is well known that a good road surface may be injured by too little as well as too much traffic; and if all the traffic is carried on in one line, it may well happen that by forming the surface in such a manner as will tend to spread the traffic over the whole width of the road, a considerable gain

may be effected, of which the true cause is not easily detected, and may be assigned to the new material, which is really due to the improved form; but when all possible explanations are given, the general experience is that the durability of tar macadam is much greater than the same stone used in the ordinary manner.

The great objection to macadamised roads in towns lies in the difficulty and cost of thorough cleansing, the muddy surface in wet weather, and the blinding dust in dry weather. Probably the greatest advantage will be found in the improved scavenging and reduced dust and mud.

Observation shows that with tar macadam it is possible to sweep perfectly clean, and if desired to wash the surface without injury; that no mud arises from the action of the stones rubbing together, but only that formed by the direct wear of the surface, i.e. one face instead of six; that in summer very little dust is made; and that the effect of street watering is much prolonged. If only these advantages are gained at a small increased cost, the result is well worth the expenditure; but when they are accompanied by a considerable annual saving, I do not think there should be any hesitation on the part of the sanitary authorities who really desire to study the health, nerves, and pockets of those whom they represent, in adopting the system advocated.

## DISCUSSION.

Mr. Lobley: I hope to hear a very interesting discussion, and that the paper will lead to some valuable remarks on the subject. It is coming to the front very considerably. I have done nothing in the matter to speak of, and I am very desirous to get a full description of how to manipulate this tar macadam. I gather from Mr. Hall's paper that he has very little to show us, and that has been cut up by various excavations. With regard to the mixture recommended for use I may first allude to Scarborough, where I was last August. It is the furthest advanced town I know in the treatment of tar macadam. In Scarborough they have made very considerable progress. Nearly all the carriage-ways in residential streets are done with tar macadam. By the kindness of the surveyor I went over the whole system. They do not mix creosote or pitch with the tar, but simply take the gas tar and store it in a large cistern and keep it as long as

they can. Sometimes they are obliged to use it quicker than they like owing to the difficulty of getting the tar. The object of storing is to let the light oils and spirits evaporate. These oils are deleterious to the work if the tar is too fresh. The long experience of the surveyor of Scarborough has been that it is better to use gas tar alone. They mix up the materials in much the same way as described by Mr. Hall. Long heaps of macadam are mixed in layers with fuel—i.e. riddled cinders, which contain a good deal of carbon—and then a little slack is put to it. The heap is then fired and allowed to get red hot. It is not allowed to get cool, as described by Mr. Hall, but the tar cold and not boiled, is put on while the stones are very hot, and thoroughly well incorporated, with the result of a further evaporation of the light and objectionable spirits in the tar. This is the reason it is not necessary to use pitch. It is done in the open air, and rain seems to have no deleterious effort upon it, and the laying of it is done in wet or fine weather, though fine weather is preferable. They use hand rollers instead of steam rollers; the only objection to it is the colour, which is black, and they consequently sprinkle a little Derbyshire spar on it which gives it a fairly pleasing appearance. What I should like to hear about is as to repairs. When depressions occur in the roadway the work of repairing those small shallow holes, seems to be the greatest difficulty in the matter. I may say I tried one street with tar macadam eight years ago. It was a street with very little traffic. I tried a mixture of tar, pitch, and creosote oil. We mixed it hot on the cold broken limestone, and when we got it into a cart we had very great difficulty in getting it out. I afterwards tried another system: laid the coating of macadam with the steam roller, then put the hot composition on it, and finished that off with limestone chippings, and a hand roller. That has been successful with that street, and is still in a good state although it is eight years since. But it would not do for heavy traffic, and is not so good as Scarborough. They use shingle off the beach instead of broken limestone or granite. It certainly makes a very good and clean carriage-way.

Mr. Ashmead: I should like to confirm what Mr. Lobley has said of Scarborough. I went over the process with the surveyor last year and took away one of his papers. It is certainly a very great success in Scarborough, and I can fully bear out what Mr. Lobley has told you. I have not tried it myself, so I cannot

say anything as to results, though I certainly very much approve of it in Scarborough. The mixture is stored in heaps for some time before being used, and if you move one of the heaps you can see it is all aglow though it has been lying there perhaps for six months.

Mr. White (Oxford): The proportions of materials mentioned differ so very widely in the various towns that it is difficult to get anything like a reliable idea of what are the correct proportions to use. I presume the stone mentioned as basalt is from Clee Hill.

Mr. Hall: I used limestone before.

Mr. White: Why is limestone preferred to basalt or granite, or any other kind of stone? I myself have used tar-paving for road-making to a small extent, but to a very large extent in footpath making. I have not used anything with the stone besides tar, but I am bound to confess that the results obtained have not been always equal or successful. For one or two streets where there would have been some trouble in consolidating ordinary macadam I have found great benefit from the employment of tar macadam, and have made very good roads. Of course the question Mr. Lobley has asked about repairing subsidences is a very important one, and I fear it is one of the difficulties of the case. I do not see any objection myself to accumulating this material, and storing it for a long time. One can only argue from one's own experience and from analogy. The footpath material I use I sometimes store for six months, and find it makes even better work if thus stored six months than when used fresh. I am rather inclined to think the Scarborough system requires more skilled supervison and watching than most of us have at our command. In my own case I heat all my stone in an oven. There are sheds adjoining with concrete floors. As soon as the evaporation from the stone ceases it is shovelled out on to the concrete floors, and the tar is taken out from the boilers and mixed with the stones, and any surplus tar not taken up by the stones drained away. Of course the material differs in quality as the process has to be carried out by unskilled labour. We want some more reliable standard than we have at present as to the composition of this material, and I think that in the discussion of this paper we may gather some information which may be of use and benefit to all the members.

Mr. Parker (Nottingham): I may say that tar macadam has been very largely used in the town of Nottingham—probably more

than in any other town in England. I shall be very pleased to obtain from Mr. Brown, the borough engineer, any information as to the method he adopts, and to send it on to any gentleman interested in the matter.

Mr. Godfrey : I have not myself been using tar macadam, but I should like to say a word or two upon the paper. I think whereever tar macadam is used for the surface of the roads, the surveyor and the council of his district must adopt a particular and careful system of cleansing. While tar macadam is dry or very wet it is a good road, but when it is in the intermediate stage it is one of the most cruel pavements in use for driving and for horses. It must also be kept scrupulously and religiously clean. If anyone has been in Holborn on a very hot day he will have noticed that the smell is simply atrocious. The use of tar macadam on the carriage roads should carry with it the understanding that it must be thoroughly and constantly cleansed, and its cleansing must take precedence of every other road in the district.

Mr. Parker : Is Holborn tar macadam?

Mr. Godfrey : No, it is asphalte.

Mr. Parker : A totally different thing.

Mr. Godfrey : It is a cognate subject.

Mr. W. de Normanville: It is a genuine asphalte. If, gentlemen, one who has had no experience of tar macadam whatever, may be allowed to say a few words, I will give you my experience of footpaths laid by the Asphaltic Limestone Company of Birmingham. They have put down a good many footpaths for us in Leamington. The difficulty one has to contend with in tar footpaths is the expansion and contraction caused by variations of temperature. I tried, but without success, to find out the method by which the Asphaltic Limestone Concrete Company succeed in making footways which are unaffected by change of temperature. One footpath we have of 24 feet wide was scarcely perceptibly affected by the severe frost of last winter, when the thermometer went down to 7° F. Mr. Melsom, the manager told me they had a special method of preparing their tar, by distilling from it the volatile oils which, when left in it, make it so liable to be affected by changes of temperature, to contract with cold and expand with heat. Their method of preparing the tar is a secret. They mix the tar with the stone in a cold condition. Perhaps those who are using an apparatus for preparing tar pavements may learn something from what I have said, and may find out some method by which they

may overcome the effects of changes of temperature. One suggestion I should like to make is that as Mr. Hall has obtained opinions from 71 towns, this information should be put together in a concise form and entered in the Minutes of our Proceedings, for, after sewage and water, the maintenance of roads is the most important thing we have to deal with.

Mr. Berrington: I should like to say that, in my opinion, Nottingham is a capital town for us to visit for an examination of roads laid on the tar macadam principle. I agree with Mr. Lobley that the roads laid with tar macadam at Scarborough are splendidly made roads. But I defy anyone to go away, after hearing this paper read, with any fair idea of the proportions in which the tar and stone are to be mixed. With regard to footpaths, I have three miles laid, and have failed to lay them properly with tar; but we have entrusted the work to a Birmingham firm, and they have done it most successfully. I should like to know the proper proportions in which the materials ought to be mixed, the price per square yard, and what it will cost to maintain?

Mr. White: Perhaps you will allow me to ask one question, that is with regard to the price of tar pavement. I see the price is given in the paper as 2*s.* 3*d.* per square yard, which seems to me to be very high, seeing that the aggregate is gravel, which is not very expensive. I find the cost of my tar paved paths is about 1*s.* 6*d.* per square yard, and under ordinary conditions of traffic the repair for the first three or four years is nothing. But taking one path with another, they require to be faced with fine material about every five or six years. Principally chippings of Hartshill stone are used.

Mr. Lobley: I think we are likely to get rather confused in these prices, if we talk of tar macadam roads, and get the price of tar footpath pavements which is very different. We have had pavements laid for us by the Val de Travers Company at 1*s.* 9*d.* per square yard, and we have tried to do it ourselves, and find we cannot do it for less than 1*s.* 9*d.* per yard and not so good. Mr. Parker, of Hereford, is present, and I should like to ask how he manages to make his tar pavements so cheaply. He gave us some wonderfully low figures when we were at Hereford last year.

Mr. Parker (Hereford): The tar pavement I have made in Hereford is simply a coating of hot tar rolled upon a good foundation. We then roll into the tar a local stone—pea gravel—which we wash at the waterworks with a machine made by Messrs.

Lamhill, of Banbury. That makes a very good surface to the path. The cost of those footpaths varies from about 5*d*. to 9*d*. per square yard. There is no secret about it, and any intelligent working man ought to be able to put it down with a water ballast roller, for a cost not exceeding about 6*d*. per square yard.

THE CHAIRMAN: Perhaps Mr. Parker will tell us the thickness of the tar pavement?

Mr. PARKER: It is painted on, if I may use the term. If you take the pavement up, as we have had occasion to do for water-pipes and other matters, you will find the tar runs about an inch in thickness. The foundation is gravel or brickbats, or anything dry. If you lay it on the clay, or too near the clay, the first frost would heave it up. We have some down in Castle Green, which has been down seven years, and in this weather it looks as nice as any pavement we have in the town. I would not recommend it where there is a heavy traffic.

Mr. LAFFAN: With regard to tar pavements I may just mention the way I have laid some. I obtain hard clinker from the gas works or other manufacturing places, carefully take from it all material of a soft coke or ashy nature, and the hard clinker which is left I have broken up. I get it screened, taking all the fine out of it with a fine screen, and form hard stuff of two sizes—one rather smaller than ordinary broken macadam, and the other the size of fine pebbles. I then mix these with the tar, always doing the work in the summer months. I sometimes mix a little pitch with it to make it a little stronger. After mixing I let it rest a day or two, and then lay it on a path which has been well beaten in with gravel or some other good foundation. I first put in the foundation, then roll it, and after that has been done some hours, lay over it two inches of the coarse and one inch of the fine material. This is done altogether at a cost of about 11*d*. or 1*s*. per square yard, and I find tar pavement of this kind, where there is ordinary traffic, to stand for seven or eight years, and then be as good as when it was first put down.

The CHAIRMAN: We have listened to a very interesting paper from Mr. Hall, and it occurs to me on looking over the information which has been supplied by the engineers of various districts that if Mr. Hall will kindly condense the information somewhat it will form a useful addition to his paper. Tar macadam is a pavement which comparatively very few of us know much about at present. I have had some footpaths laid down with tar, and I must say I

was not pleased with the result. It is right, however, to mention that those pavements were laid on stiff clay. The foundation was six inches of broken brick rubbish, on which the tar and stone were laid. Any one who has had to deal with clay—especially London clay—will know how the variations of temperature affect it. It expands and contracts to such an extent that cracks show all over the surface. That is a difficulty we have to deal with in London with asphalte—not so much mastic asphalte as compressed. I don't know whether there is any macadam roadway in London made with tar. I should much like to see the result of such a pavement in London suburbs, because the traffic as you know, even in the suburbs, is very heavy, and the life of a pavement depends a good deal upon the traffic passing over it. When the traffic on a roadway is such as to necessitate remacadamising every twelve or fifteen months, I think it is time to consider what permanent pavement should be laid; and if this tar macadam would take the place of the more expensive forms of pavement—wood, asphalte, or granite cubes—it would be an advantage to many suburban districts and provincial towns. I must express my thanks to Mr. Hall for the interesting paper he has given us, which I am sure you will all endorse. Mr. White informs me that on clay surfaces he has found even Staffordshire blue brick pavements have become badly cracked. Now that is interesting, because any gentleman going from a gravel district to a clay substrata may carry his ideas and methods of work into the district where there is a clay foundation. If so he will find the results will be very different from what he expects. Mr. White says he has put on 3 inches of gas ashes under the pavement and that prevents cracking, as it stops the contraction or expansion. I have, during the past twelve months, adopted a similar method, using ashes and broken furnace clinker between the clay and the foundation of the pavement.

The thanks of the meeting having been accorded to Mr. Hall for his paper,

Mr. Hall, in reply said: I must confess I am somewhat disappointed with the discussion, because in preparing the paper I was not thinking so much of telling you how to make tarred macadam roads as to ask you how to do it. I sent to everyone of the members whom I knew to be in the habit of making tarred roads. I was surprised to find by the replies that the proportions of material used showed such a wide range, and that with the most diverse proportions equally good results were obtained. The two

men who give the most extreme variations are the two men who give the best results. The storage of the tar at Scarborough points to its being a continuation of the old system of heating the stone and pouring the tar upon it when hot. There is no doubt the tar does improve by storage just as it does by distillation. Mr. White asks why limestone is preferred as a material for the roads. You find a limestone road wears fairly evenly, and is slightly absorbent, which is not in the case of harder materials. With reference to Mr. Godfrey's question, of course all our streets ought to be perfectly cleansed, we do not recognise anything short of that, but I think he is comparing the poor country tar pavement with the town asphalte. Tar pavement is undoubtedly slippery, but I have not seen any cases on fairly level roads where it could be called dangerous. I have also seen ordinary macadam roads quite as slippery. The expansion from frost Mr. de Normanville refers to is due to the quantity of water contained in the tar. If you once get that water out of the tar it never gets in again, and there is no fear of expansion.

The CHAIRMAN: Before we adjourn from this room it is my pleasant duty to ask you to accord a hearty vote of thanks to the Mayor and Corporation of Cheltenham for kindly granting us the use of the Council-chamber this morning. We can only regret that the Mayor was unable to be present, but we hope to see him during the afternoon.

*The members then drove in brakes to the waterworks, and after an inspection of the reservoir, were entertained to luncheon by Mr. Hall.*

*After which the Members drove to Pittville Gardens, and afterwards to the Sewage Works, which were inspected; they proceeded thence to the new destructor which is being erected in close proximity. The destructor, which is to be fitted with eight cells and two Jones's cremators, is being substantially erected by Messrs. Manlove, Alliott and Company.*

# DISTRICT MEETING AT STOURBRIDGE,

**May 23rd, 1891.**

*Held in the Board Room at the Town Hall, Stourbridge, by kind permission of the Improvement Commissioners.*

H. P. Boulnois, President, *in the Chair.*

Mr. C. H. Collis, the Chairman of the Improvement Committee, opened the proceedings by cordially welcoming the Association to Stourbridge. The President having replied, acknowledging the compliment. Mr. A. T. Davis was re-elected Honorary Secretary for the Midland District.

The following papers were then read and discussed:—

## THE SEWAGE DISPOSAL WORKS OF THE STOURBRIDGE MAIN DRAINAGE BOARD.

By W. FIDDIAN, F.S.I., Surveyor to the Board.

Before describing the works you are to visit to day, some general information as to Stourbridge and district may not be out of place. The town of Stourbridge is one of six townships (more or less closely connected with each other) which form the parish of Old Swinford. Of these, Stourbridge only has urban government, the remaining townships of Lye, Wollescote, Upper Swinford, Wollaston, and Amblecote, being in the area of the Stourbridge Rural Sanitary Authority. The parish has both a residential and industrial character. The chief manufactures are—fire-clay goods, including glazed bricks and baths; branded bar-iron (at the works of Messrs. John Bradley & Co., where the first locomotive used in America, the "Stourbridge Lion," was made); flint and other glass;

leather and fellmongery goods; buckets and other galvanised sheet-iron articles; chains, nails, anvils, vices, &c. About one-half of the parish is on the new red sandstone formation, the remainder having a brick clay surface overlying the coal and fire-clay measures.

The area population (1881) and rateable value of the several townships is as follows:—

| Name. | Area in Acres. | Population in 1881. | Rateable Value. |
|---|---|---|---|
| *Stourbridge .. .. .. .. .. .. | 420 | 9,756 | 29,744 |
| *Upper Swinford .. .. .. .. .. | 977 | 3,203 | 12,166 |
| *Wollaston .. .. .. .. .. .. .. | 466 | 2,414 | 5,575 |
| *Amblecote .. .. .. .. .. .. .. | 650 | 2,808 | 13,937 |
| | 2,513 | 18,181 | 61,422 |
| Lye .. .. .. .. .. .. .. .. .. | 323 | 6,323 | 11,780 |
| Wollescote .. .. .. .. .. .. .. | 452 | 3,059 | 4,782 |

* In the Stourbridge Main Drainage area.

## Main Drainage Board.

In consequence of threatened proceedings for pollution of the River Stour, steps were taken by the Stourbridge Improvement Commissioners in 1880 for obtaining a scheme of sewage disposal for the township of Stourbridge. The late Town Surveyor, Mr. John Taylor, was instructed to report on the subject, and with the author's assistance prepared a report which—*inter alia*—pointed out the desirability of the adjoining townships combining with Stourbridge in the provision of works for sewage disposal. As a result of negotiations with this object between the Commissioners and the Rural Sanitary Authority, a Provisional Order was obtained in 1881 for forming the Stourbridge Main Drainage Board. The district of the Board was limited to the townships of Stourbridge, Upper Swinford, Wollaston, and Amblecote; the other two townships in the parish of Old Swinford being left out on account of local opposition. The works as now constructed were designed and carried out in 1884 by the author, whom the Board appointed as their Surveyor. These comprise main sewers (for collecting at numerous points of outfall the sewage of the several contributory places), converging at a pumping station, from which the sewage is conveyed through a rising main to a farm about two miles distant, and there dealt with by broad irrigation.

## Main Intercepting Sewer.

The three principal sewers radiate from the pumping station in eastern, southern, and northern directions, and have several lateral branches, their total length being 9760 yards. Each principal sewer for some distance from the outfall is constructed of brick and is of egg-shape section, 4 feet 6 inches by 3 feet, and these portions together provide tank room for about 170,000 gallons of sewage. This provision allows pumping to be discontinued for some hours in the night, and equalises the work to be done by the engines. The falls are such as to make the tank sewers self-cleansing if the flow was continuous, but deposit gradually accumulates whilst the sewage is being stored. Most of this deposit is removed at intervals of three months, by sewer men brushing the sides of the sewers and agitating the sewage whilst flowing freely to the pumps. By this means nearly the whole of the solids are taken up again in the sewage and passed on to the farm, some 10 to 15 cubic yards only of heavy silt having to be removed from the sewage-well to the surface. The average cost of cleansing these sewers is about 30*l.* per annum. After leaving the above described tanks, the sewers are constructed of 18-inch to 12-inch pipes, chiefly of earthenware, but short lengths of cast-iron pipes are laid in wet or difficult ground, and at the canal and river crossings. On the eastern sewer there is a 15-inch wrought-iron tube spanning a portion of the river Stour in two lengths of 54 feet each. Most of these sewers follow the valley lines of the district (to a large extent through private lands), and provide a number of convenient outfalls in each of the contributory places. Considerable difficulty was experienced in their construction, from the presence of subsoil water and running sand in the earthworks. Generally the pipes had ordinary cement joints, but where the ground was very bad or much water was met with they were surrounded with clay puddle. Some lengths were also laid with pipes having Stanford joints, and others with cast-iron pipes. The brick-built tank sewers were several feet under subsoil water level, and were built over sub-drains leading to a pump well from which large volumes of water were lifted during the period of construction. This well now supplies condensing water to the engines, at the pumping station, by a suction pipe attached to the condensers. Before the completion of the works the water entering the sewers amounted to 150,000 gallons per day, and on examination it was

found that a large portion of this quantity entered in a few short lengths. These were specially dealt with to great advantage. Further benefit was experienced from the lowering of the subsoil water level near the pumping station, by using the water for condensing in the manner before mentioned. The subsoil water entering the sewers was thus brought down to about 50,000 gallons per day. Probably a free use of pipes with the improved forms of joint which are now to be had, would have given better results, though at an increased capital outlay; but these were neither so well known nor tested by use then, as they are at the present time. The Stanford joints which were used did not prove so satisfactory as to warrant their general adoption.

## Pumping Station.

The site of the above adjoins the river Stour below the town of Stourbridge, but not at the lowest part of the district. A portion of the Amblecote and Wollaston sewage is brought to it by a sewer running about half a mile up the Stour valley, with a contrary fall to that of the river. The three tank sewers referred to deliver the sewage into a penstock chamber connected with separate pump wells outside the engine house, into which latter the suction pipes of the pumps are carried.

The erections consist of an engine house, boiler house, chimney stack, stores and weigh house. The land had probably at some period formed the bed of a mill pond, as an oak floodgate sill was found in the excavations. Some 16 feet of alluvial deposit and soft clay had to be passed through, before reliable foundations could be reached. The walls of the engine house were carried down to the sandstone rock to form the pump chamber, and the foundations of the stack also commenced on the same strata. All the other erections stand on concrete pillars, resting on the sandstone and carrying a concrete entablature (near the surface level), from which the walls were started.

The plant consists of duplicate vertical and inverted compound condensing engines, with ram pumps and separate suction pipes and air vessels. These were supplied by Messrs. Hathorn, Davey, & Co., to a general specification, and are fitted with their differential gear. The cylinders are 16-inch and 26-inch diameter, with 4 feet stroke. The two piston rods are directly connected to the pump plungers, and their relative position is controlled by grass-

hopper beams. The pump plungers are loaded by cast-iron balance weights to an extent somewhat in excess of the pressure on them due to the column of sewage in the rising main. These weights—by the inertia of their mass—counteract the falling pressure of the steam as the stroke advances, and prevent "knocking" in the beam and cross-head bearings. There are two Cornish boilers, each 26 feet long by 6 feet diameter, with 3 feet flue; one only of which is ordinarily used. These are supplied with feed-water by means of a donkey-pump, but an injecter is provided in case of accident or repair to the pump. The feed-water is passed through a Green's economiser fixed in the main flue to the stack. The working pressure of the steam is 60 lb. to the square inch. Each engine is capable of raising one million gallons of sewage per day to a height (including friction in the main) of 145 feet above the level of sewage in the pump well. The average daily quantity of sewage pumped in 1890 was 536,000 gallons. Estimating the population of the district at 19,000, this would be about 28 gallons per head per day. The average daily consumption of slack during the same period was 31½ cwts. In addition to domestic sewage, it is estimated that some 70,000 or 80,000 gallons of manufacturers' waste fluids are daily passed into the sewers. Probably the houses of about one-fourth of the population are supplied with water-closets.

## Rising Main.

The cast-iron main, from the pumping station to the farm, is 14 inches in diameter, and 2⅛ miles long. About half way to the farm it crosses a ridge of high ground at a level of 156 feet above the inverts of the tank sewers at the pumping station, and 38 feet above the main outfall at the farm. With the object of reducing the summit level of the main, the question of the desirability of tunnelling through the crest of the hill was considered. To lower the level 30 feet it was found would require deep open cutting and tunnel 400 yards in length, passing for the most part through beds of conglomerate and very hard sand rock; the interest on the capital outlay for which would almost equal the saving to be effected in the cost of pumping. It then occurred to the author that the same effect could be obtained by causing the portion of the rising main crossing the ridge to act as a siphon. The problem to be solved was the freeing of the siphon part of the main from air, and charging it with sewage from time to time

as may be necessary, without the use of an exhausting apparatus or the employment of extra labour. This result has been obtained by an arrangement devised by the author, the action of which members will have an opportunity of inspecting to-day. The following is a description of the means adopted:—At the highest part of the main (which is 10 feet below the surface of the ground) a vertical standpipe 9 feet high is fixed, having at its base a valve intended to pass air from the main to the outside atmosphere. This valve is of the hatband type (the band being of indiarubber), and is easily removable for examination by withdrawal up the standpipe. The outfall end of the main at the farm is curved upwards, so as to deliver the sewage vertically, and is fitted with a valve seat of 10-inch orifice. A lever-weighted valve —similar to the safety valve of a steam boiler—closes this orifice, with a pressure corresponding to that of a column of sewage of a height equal to the difference of level between the outfall and half way up the standpipe. The lever is extended past its fulcrum in an opposite direction to the weighted end, and carries a light iron tank having a 4-inch leakhole in its bottom, into which tank all the sewage is made to pass on the lifting of the valve. This tank, when full, acts a counterweight sufficient to raise the valve fully open without the assistance of pressure in the main. When the pumps are stopped, the sewage in the tank runs off through the hole in the bottom, and the valve goes on to its seat with the full effect of the weighted lever.

To charge the siphon, all that is necessary is to start the pumps, when air in the main at the summit is gradually driven out through the air-valve in the standpipe until the main is filled with sewage. The latter then passes through the air-valve, and rises some 4 feet in the standpipe, when the pressure at the outfall becomes sufficient to raise the weighted valve on the end of the main. Sewage now rushes into the counterbalance tank, and lifts the valve full off its seat, liberating the contents of the long leg of the siphon and starting it in action. The effect on the engines is, at the same time, shown by a reduction of nearly 30-feet head on the pressure gauge at the engine-house, during which reduction of head the cut-off gear is adjusted to act earlier, and the consumption of steam is correspondingly reduced. The action of the siphon continues almost unaffected for five hours on the average, when it slowly begins to show deterioration. After six hours' work it is usual to stop the engine, and, allowing a short

interval for the valve at the outfall to close, start it again, when what the engineman calls a "good siphon" is obtained. The object of passing sewage through the air valve, and up the standpipe, is to prevent air leaking through the valve into the main, and so destroying the vacuum. The description of this method of charging the main for the purpose of siphonage has been fully described, because it is believed to be novel, and may be useful in other cases where the conditions are similar.

## Sewage Farm.

This is situate at Whittington Common, in the parish of Kinver, and consists of about 130 acres of land, formerly part of a common. Some of the inclosures were uncultivated when the land was purchased by the Drainage Board, being drifting sand banks or game covert. The subsoil consists of from 5 to 8 feet of loam sand, with a few pebbles, overlying the rocks of the new red sandstone formation. The surface is undulating, and some parts are rather steep for irrigation purposes; especially when the soil has been disturbed by cultivation. Very little levelling was done to the surface, beyond removing sand banks and filling up local depressions. There were no buildings on the land when purchased, the present farmstead and cottages having been erected by the Drainage Board. The end of the rising main—controlled by the pressure valve before described—is inclosed by a small building, and delivers the sewage at a level high enough to allow of its being passed on to the whole of the land, except some 5 acres adjoining the main outfall chamber. The latter is reached by a short continuation of the main, of lesser diameter, controlled by a sluice valve. When this small area is being irrigated no siphonage is obtained in the rising main. The distribution of the sewage is by underground earthenware pipe carriers, on the lines of which are brick distributing sluice chambers, averaging about 100 yards apart. The sizes of the carriers vary from 15 inches to 6 inches (chiefly 9-inch and 6-inch), and their total length is 7650 yards. The pipes are ordinary socketed, but were carefully jointed in cement so as to carry internal pressure. The closing of a sluice causes the sewage to accumulate in the chamber and carrier until it reaches the surface level, where its passage on to the land is controlled by a flap valve on the outlet pipe. Any quantity of sewage above that required to be deliverd at a particular chamber

passes over a weir in the chamber into the next lower length of carrier, where the same process is repeated. This arrangement allows an easier control of the quantity of sewage to be delivered at particular points, than that obtainable by opening the sluice more or less, and the distribution to the several chambers when the flow varies is more even. A moderate number of leaky joints were found on the first testing of the carriers, but these were easily located from surface appearances and made good. The smaller ones took up almost immediately after the sewage pressure was applied, and the whole have since given little or no trouble. One length of these carrier pipes forms a long inverted siphon with a maximum pressure of 15 feet, but the joints of the lower portion of the siphon have the addition of a ring of cement concrete. The farm has been let by the Board to the present tenant from the commencement. A lease for five years was entered into three years ago, the rental being 225*l.* per annum. Part of the cropping is in rotation, viz. first year grain, with which is sown Italian rye-grass seeds for second year's crop. The rye-grass turf is ploughed up, and a potato crop taken in the third year, which is followed in the next season by swedes, mangolds cabbages, and other green produce.

By this method excellent crops of potatoes are obtained, with little irrigation of the crop, the manurial constitutents required being provided by the heavy sewaging of the rye-grass in the previous season and the decaying roots of the ploughed-up turf. The average acreage of the various crops is as follows:—Grain 20, rye grass 20, potatoes 25, swedes and mangolds 25, parsnips and carrots 10, cabbages, market garden produce, &c. 25 acres. The greater portion of the produce is sold off, and only so much consumed on the farm as cannot satisfactorily be otherwise disposed of. The tenant is occasionally allowed to supply adjoining farmers with sewage, and probably one-seventh of the total quantity is thus dealt with. Only the lower portions of the farm have been drained, and this has been done from time to time, where found necessary. The drains deliver into a main effluent drain, 12-inch diameter and 2700 yards long, which conveys the effluent to the river Stour at Whittington, this being the nearest stream to the farm. The average observable flow of effluent water from the and is not more than about one-twentieth of the total quantity of sewage delivered. No complaint has been received, either of the quality of the effluent, or of nuisance at the farm.

### Cost of Works.

| | £ | s. | d. |
|---|---|---|---|
| Main sewers .. .. .. .. .. .. .. .. .. .. .. | 6850 | 0 | 0 |
| Erections and plant at pumping station .. .. .. .. | 5700 | 0 | 0 |
| Rising main .. .. .. .. .. .. .. .. .. .. .. | 3100 | 0 | 0 |
| Farm buildings, two cottages, and appurtenances .. .. | 1425 | 0 | 0 |
| Preparation and levelling of farm .. .. .. .. .. .. | 300 | 0 | 0 |
| Carriers and distributing chambers .. .. .. .. .. | 1000 | 0 | 0 |
| Drainage of land .. .. .. .. .. .. .. .. .. .. | 150 | 0 | 0 |
| Effluent drain from farm to river .. .. .. .. .. .. | 600 | 0 | 0 |
| Land for pumping station and farm .. .. .. .. | 5750 | 0 | 0 |
| Total .. .. | £24,875 | 0 | 0 |

### Annual Working Expenses of Pumping Station.

| | £ | s. | d. |
|---|---|---|---|
| Wages—including cleansing tank sewers .. .. .. | 260 | 0 | 0 |
| Fuel, 575 tons at 8s. .. .. .. .. .. .. .. .. .. .. | 230 | 0 | 0 |
| Oil, waste, valve leather, packing, and other stores .. | 40 | 0 | 0 |
| Repairs .. .. .. .. .. .. .. .. .. .. .. .. .. | 35 | 0 | 0 |
| Boiler insurance and gas .. .. .. .. .. .. .. .. | 20 | 0 | 0 |
| Total .. .. .. | £585 | 0 | 0 |

The above working expenses are at the rate of £3 per million gallons pumped.

### Collecting Sewers.

On the completion of the Main Drainage Works the urban and rural authorities, carried out in their respective districts, according to the plans and under the supervision of the author, complete systems of sewage. The old sewers are used to convey the rainfall as far as possible. Automatic flushing chambers are provided at all important dead ends of sewers. The ventilation of the sewers is chiefly by the surface gratings of manholes. The length of the collecting sewers is 19½ miles, and their total cost was about £11,000. The average annual zymotic death rate of the Drainage Board district for the four years before the completion of these works (1883–1886) was 2·7 per thousand; and for the four years after (1887–1890) was 1·5 per thousand.

# MARKET HARBOROUGH, GREAT AND LITTLE BOWDEN WATERWORKS.

By HERBERT G. COALES, Assoc. M. Inst. C.E., Engineer and Surveyor to the Local Board.

In a paper on the sewerage, sewage disposal, surface and house drainage of Market Harborough, Great and Little Bowden, read before the Association in June, 1886, Mr. E. G. Mawbey, Assoc. M. Inst. C. E., the present Borough Surveyor of Leicester, intimated that a scheme of water supply was contemplated for this district. The work has now been completed, Mr. J. B. Everard, M. Inst. C. E., F.G.S., of Leicester, having been the engineer; the author, in addition to his ordinary duties as Surveyor to the Board, acting as resident engineer for the works within the district, and Mr. John Manley for those without. The population of the district is about 6000, the area being 4416 acres, and the rateable value 38,000*l.*

## Old Supply.

Market Harborough is situated on the lias clay formation, which of course is not in itself a water-bearing stratum. On this lias clay are surface deposits of gravel, &c., of a shallow nature, which receive and hold that surface drainage water which, owing to the impermeable nature of the clay, cannot penetrate into that formation. From these surface deposits, then, was the whole of the drinking water in the district drawn, and when it is mentioned that previous to the new main sewerage being carried out, the old drains were in leaky condition, it may be imagined how dangerous that supply was. The shallowness of the wells was proved by the frequent complaint that the excavations for the new sewers had drained them. Previous to the completion of our present works, the waterworks of the town consisted of nothing more than a dozen public pumps, the waters of which have in each case either been condemned by analysts or become dry.

## Source of New Supply.

The level of the street in the centre of the town is 253 feet above the Ordnance datum; but to command the highest house in

the district, a water-level of 415 feet was required in the service reservoir. To avoid a pumping scheme it became necessary to go very far afield to obtain a supply which would deliver naturally into this reservoir.

The Local Board having requested Mr. Everard to report upon the best means of supplying Market Harborough, Great and Little Bowden, with water, the now completed scheme was brought forward and approved, with the concurrence of Mr. James Mansergh, C.E. It is a gravitating scheme, absolutely unencumbered by any annual working expenses such as pumping, softening, or filtering. The source, however, is 8¼ miles away, lying partly in the parish of of Husband's Bosworth, and partly in the parish of North Kilworth, in the county of Leicester, land having been purchased by the Local Board in both parishes, "with full and exclusive power, liberty, and authority to have, use, and take all water now flowing or what may hereafter flow through, upon, or over the said land." The vendors are also debarred from doing anything to the neighbouring land which might prevent the full flow of the water through the subsoil to the places at which it now issues.

Previous to the acquisition of the land, permission was obtained for numerous trial holes to be sunk, and constant gaugings were taken for a considerable period, with very satisfactory results.

About one-half of the purchased area is grass land, bounded on the south-east by a stream; and the other half is underwood, bounded on the west by the same stream, which divides the two parishes. The land is half a mile in length, and averages from 33 to 100 yards in width.

The water is obtained for the most part from a bed of rock, this being one of the upper limestone beds of the lower lias.

In North Kilworth parish a well is sunk about 26 feet deep, and goes through drift gravel, in which only a small quantity of water is found, through lias clay to the bed of rock, which is nearly 1 foot thick. From near the bottom of this well a heading is driven in which 12-inch stoneware socket pipes are laid, with junctions at suitable points provided with perforated stoppers, the average depth being about 24 feet, for a length of rather more than 300 yards, with manholes at intervals. At the upper end extensive beds of gravel are found, and these are utilised as a natural reservoir, calculated to store 7,000,000 gallons, the water being kept back by a wall of puddled clay, but means have been adopted for automatically drawing off this water when it is required.

A second well sunk in Husband's Bosworth parish is about 24 feet deep, and is entirely in gravel, but a boring at the bottom of the well taps the rock below.

The water from both wells is conveyed by two 7-inch iron pipes to the valve house situate in Husband's Bosworth parish, and the supply is at this point automatically regulated by two self-acting float valves. There is also a small tank with screen, and in this tank begins the long 10-inch supply main which conducts the water to Market Harborough.

The water in the valve house is 450 feet above Ordnance datum, and the surface of the water on the upper side of the puddle wall is 473 feet.

The river Avon (which takes its rise from Naseby, at a height of about 560 feet above Ordnance datum) receives the surface drainage of the locality.

The wells are 8 feet in diameter, and are built waterproof, except where provision has been made for the admission of water wherever it appeared in the excavation.

A daily supply of 170,000 gallons may be relied upon.

The following is an analysis of the water obtained from each of the two wells, as given by Mr. Charles E. Cassal, F.I.C., F.C.S.:—

| | From Well in North Kilworth land. | From Well in Spinney, Husband's Bosworth land. |
|---|---|---|
| Appearance in 2-ft. tube | Clear. No marked colour. | Clear. No marked colour. |
| | Grains per gallon. | Grains per gallon. |
| Total solid matters | 44·8 | 34·3 |
| *a.* Volatile | 18·2 | 12·6 |
| *b.* Fixed | 26·6 | 21·7 |
| Total hardness | 23·8 | 21·7 |
| *a.* Permanent | 12·6 | 7·7 |
| *b.* Temporary | 11·2 | 14·0 |
| Chlorine | 0·98 | 0·98 |
| Equivalent to common salt | 1·614 | 1·614 |
| Nitrogen as nitrates | 0·065 | 0·098 |
| Saline (or "free") ammonia | 0·0021 | 0·00098 |
| Organic (or "albuminoid") ammonia | 0·00392 | 0·00364 |
| Poisonous metals | Absent. | Absent. |
| Microscopic examination of the sediment | A very little mineral matter. | A very little mineral matter. |

*Remarks.*—No perceptible browning of solid matters on heating.

The rainfall at the source of supply, so far as it has been gauged, is given below:—

| Name of Month. | Rainfall, 1884. | Rainfall, 1885. | Rainfall, 1890. |
|---|---|---|---|
| January .. .. .. | .. | 1·53 | 2·19 |
| February .. .. .. | .. | 2·40 | 0·92 |
| March .. .. .. .. | .. | 0·85 | 2·08 |
| April .. .. .. .. | .. | 2·50 | 0·92 |
| May .. .. .. .. | .. | 2·02 | 1·58 |
| June .. .. .. .. | .. | .. | 1·86 |
| July .. .. .. .. | .. | .. | 3·10 |
| August .. .. .. .. | .. | | |
| September .. .. .. | 0·79 | | |
| October .. .. .. .. | 1·50 | | |
| November .. .. .. | 2·39 | | |
| December .. .. .. | 2·51 | | |

## Ten-inch Supply Main.

The supply main is 8¼ miles long. Passing through fields from the valve house for a quarter of a mile, the pipes cross the line of the Rugby and Stamford railway, and for a distance of 1 mile 9 chains are laid by the side of the railway, for which easement the board pays a quarterly rent of £5. Crossing two more fields, the Market Harborough and Lutterworth turnpike road is reached, and the main is laid on the grass, about 4 feet from the macadam, all the way to Market Harborough, passing through Theddingworth and Lubenham villages. The pipes have a covering of not less than 2 feet 6 inches, but generally more.

At each great depression a washout and relief valve are provided, and a large air-valve on the summit of each hill.

The pipes are jointed with cold-drawn rings of lead driven hard into the socket, and melted lead is run into the space which is left, with a minimum depth of 2⅝ inches.

Within the district, sluice and ball hydrants are fixed at a distance of 100 yards apart.

The hydraulic mean gradient of the main is 1 in 1242; and the fall from the surface of the water in the valve house to the surface within the reservoir is 35 feet. The difference in level between source and top of Theddingworth hill, which is the highest intermediate point, is 15 feet. The delivering capacity of the main is about 350,000 gallons per day.

## Service Mains.

There are about 65 yards of 8-inch service mains; two miles 1410 yards of 6-inch service mains; five miles 850 yards of 4-inch

service main; and 1380 yards of 2-inch service mains. A total of more than 9 miles.

The average pressure in the town is from 80 to 90 lb. per square inch.

Ball hydrants are fixed at intervals of about 100 yards. No hydrants are fixed on mains having a less diameter than 4 inches. Relief valves are provided at the extremities of the mains. The necessary washouts, air valves, sluices, and stand watering posts are also provided. The water has a good circulation throughout the district, there being very few dead ends.

At the back of each socket a boss is cast on the pipe in which the ferrule is inserted.

At two river bridge crossings, where the road material was only a few inches deep, the pipes were surrounded with a wrapping of slag wool and concreted. This proved a sufficient protection from the severe frost of last winter.

Having given the proper notices, the board laid mains up all private streets at their own cost.

## Pipe Testing.

In the pipe contractor's specification was a clause requiring the whole of the pipes and special castings to be subject to proof by hydrostatic pressure, according to the following schedule, the pipes being struck with a hammer in all their parts whilst under pressure, the examination taking place under cover from rain.

| Diameter of pipe. | Thickness of pipe. | Proof pressure equal to a column of water. | Or lb. per sq. inch. | Maximum pressure in feet to which pipe will be subjected in work. |
|---|---|---|---|---|
| in. | in. | ft. | | |
| 10 | $\frac{1}{2}$ | 450 | 195 | 205 |
| 8 | $\frac{1}{2}$ | 450 | 195 | 205 |
| 7 | $\frac{7}{16}$ | 300 | 130 | 20 |
| 6 | $\frac{7}{16}$ | 400 | 195 | 205 |
| 4 | $\frac{3}{8}$ | 500 | 217 | 215 |
| 2 | $\frac{5}{16}$ | 500 | 217 | 210 |

In addition, test-bars of the metal actually used in casting were proved. a bar of 1 inch square and 38 inches long, weighing not more than 10 lb. was required, when supported at points 36 inches apart and loaded in the middle, to sustain a weight of not less than 700 lb.

A pipe inspector was appointed to see that these provisions were carried out at the foundry.

The contractor was not absolved, by such testing, from making good defects which might afterwards be discovered, the specification specially holding him responsible for defective castings which might be detected within twelve months of the certified completion of the works.

As a matter of fact, every pipe was re-tested after being laid and jointed in the trenches, in compliance with a clause in the general contractor's specification, requiring that the whole of the pipes and fittings, after being laid, jointed, and fixed, and before being covered up, were to be tested by the contractor at his own cost by hydraulic pressure up to 50 lbs. per square inch more than the working pressure.

The first consignment of 180 10-inch pipes, delivered at Market Harborough station, were unloaded by the railway company's own men during frosty weather, the pipes being covered with a rime which made it impossible for a proper inspection to be made of them then. It was not for two or three days, the frost having gone, that the author discovered no less than 45 fractured pipes in the stack; the fractures occurring in almost every case at the spigots, extending from one to several inches in length. This was the commencement of a long list of rejected pipes, the sum at completion of works numbering the large total of about:—

| | |
|---|---|
| 460 10-inch pipes. | 97 4-inch pipes. |
| 89 6 " " | 10 2 " " |

weighing about 141½ tons, or over 8 per cent. of the weight delivered.

It may readily be imagined that one's confidence in the soundness of the pipes was shaken, and that the second test was welcomed as a most necessary supplement.

The apparatus used was a Tangye's boiler tester and pressure gauge, with a short length of strong hose, with stop tap for attaching to the main.

The *modus operandi* was as follows:—The nearest sluice being shut down, the pipes were filled with water, the last pipe laid being capped with a short socket and flange piece, to which was bolted a stout boiler plate. The pressure was then applied, the hose having been previously screwed into the main. When the gauge registered the required pressure each pipe and joint was examined.

Sometimes a pipe split or burst, and had to be cut, burnt, or broken out, the void being made good with a new pipe and collar joint. Two serious hindrances to the speed of the work were the scarcity of testing water, and the expulsion of the air in the mains. It was not found possible to drive the supply main from the source only, so it was commenced at the service reservoir also, and it was at this end that the difficulty of getting the pipes filled with water occurred; at the other end the water of course followed the workmen.

Water-carts and vans were employed, but it was a slow business to fill half a mile, more or less, of 10-inch main. On more than one occasion a manual fire-engine was requisitioned, and the water raised some 54 feet from a brook more than 200 yards away. By reason of several bursts, and consequent waste of water, the author must confess to having allowed no less than three-quarters of a mile of main to be open, at one time, along a main road. In this particular length burst after burst occurred, for as soon as one was repaired and the pipes refilled and the pressure applied, another pipe would go. In this way we had to make good six breakages—a very tedious affair.

The following extracts from diary may be given as a detailed account of the breakages:—

*June* 7, 1890.—Tested length from Catholic chapel to Plowman's nursery. One pipe split at 50 lb. pressure (having leaked at a lesser pressure), and one socket broke also. Both failures were old flaws. Fire-engine used for filling pipes.

*June* 16.—Testing 10-inch main from Catholic chapel to Plowman's. Fire-engine out again. Pipe split again at 55 lb. Old flaw in body of pipe; tar in crack.

Testing 10-inch main from Plowman's to top of hill. Pipe split at 10 o'clock p.m., at 110 lb., opened at a lesser pressure. Old flaw; tar in crack.

The whole of the men engaged all day up till about 10 o'clock p.m. testing with fire-engine.

*June* 17.—Testing 10-inch from Catholic chapel to Plowman's nursery. Fire-engine out again. Piece of pipe 7 feet long, and weighing about 1½ cwt., blown out at 100 lb. Old fracture in pipe, 19 inches long, with tar in crack almost through.

Testing length from Plowman's nursery to top of hill at 8 o'clock p.m. At 110 lb. (the proper test) a core nail (apparently) was blown out, and the water squirted out. Had it

temporarily made good, and gave permission to have rest of length filled in.

*June* 18.—Testing 10-inch main from Catholic chapel to Plowman's nursery. Could not get pressure up after five hours pumping (10 o'clock p.m.), owing to the sluice not being quite tight; probably a stone had got in.

*June* 19.—Tested length from Catholic chapel to Plowman's again; satisfactory at last.

The pipe contractor was charged all the expense of making good and re-testing the lengths in which failures had arisen, it having first been clearly demonstrated that the pipes were faulty, either by the presence of old flaws, or the evidence of thin metal. It was of the rarest occurrence for a joint to be found weeping, and, I believe, in every case an application of the caulking tool remedied the defect.

That the whole 8 miles of supply main was strictly tested is shown by the fact that, after being under pressure now for about six months, no burst has occurred.

With regard to the expulsion of the air, where the main was laid along a level bit of road, it not infrequently took six hours to get the pressure up; whereas when laid up a hill, less than half an hour would suffice to test the length.

## SERVICE RESERVOIR.

The service reservoir is built upon the Burn Mill Hill, an eminence which is sufficiently high to command every house in the district, and is about midway between Market Harborough and Great Bowden. The reservoir is circular in form, having an internal diameter of 96 feet, and a water depth of between 11 and 12 feet, its capacity being 500,000 gallons, or about three days' supply. The ground, which was chiefly clay, was got out to a depth of about 6 feet 6 inches, the excavated material being used in the embankments. The floor is of concrete, and the walls are also of concrete faced with red bricks, and it is made watertight by a lining of cement, this lining being protected, both in the walls and floor, by a facing of blue vitrified brickwork.

A low wall divides the reservoir into two equal parts, so that in case of cleaning or repair, one side can be used.

The whole is covered in by groined concrete arches, resting upon twenty-four blue brick piers in two rows radial from centre. The centering was nicely constructed, and no settlement took

place after the wedges were struck, the concrete forming a strong and effective piece of work.

The walls are 3 feet 8½ inches thick, and the floor about 1 foot 5 inches.

The supply inlet is provided with an automatic float valve, which closes just before the water reaches the level of the overflow pipe.

The reservoir is washed out down an 18-inch waste pipe, which is laid into a ditch with a rapid fall.

The cement used in the construction of the work was from the Rugby Cement Company, and was tested to a tensile strain of 450 lb. per square inch, after being exposed to the air for one day and being placed under water for six days. It was spread out, 6 inches thick, for a period of fourteen days on a dry boarded floor, and turned over every two days, before being used.

The cement concrete to roof was in the proportion of 5 to 1; the uppermost part of wall 6 to 1; and the remainder of the work, including the floor, 7 to 1. The aggregate of the concrete was composed of broken granite and slag, and granite gravel, the whole of such a size as would pass through a gauge 1½ inch diameter.

A central ventilator, having an internal diameter of 3 feet 6 inches, is fixed in the roof.

The top and slopes of reservoir are soiled and turfed, the batter of the latter being 1½ to 2. The ground under reservoir is drained with common land tiles, as is also the embankment surrounding same.

Prior to the brick lining being put in, the reservoir was filled with water, to test the watertightness of the cement lining. The leakage was considerable, 412 gallons an hour escaping down the waste pipe. The water being run out, one-half of the floor was skimmed over with neat cement, and the footings of the division wall also rendered, the discharge of the subdrains pointing to the fact that the water found an outlet under this wall. Upon refilling the reservoir, the work was found to be perfectly tight, so that the brick lining could be put in.

The water was admitted into the finished reservoir at 6.10 a.m. on October 8th, 1890, and was full at 5.23 p.m. on October 10th.

## Cost.

The total cost of the waterworks has been nearly 24,000*l.* The work was let in three contracts, Mr. J. T. Wingrove, of Northampton, securing the first, for general work, at 8,488*l.*; Messrs. C. E.

Firmstone and Bros., of Stourbridge, the second, for iron pipes and specials, at 8,935*l.*; and Messrs. Hamilton, Woods, and Co., of Manchester, the third, for valves and fittings, at 855*l.*

Delay in the execution of the scheme cost the Local Board about 1,300*l.*, iron having gone up considerably in price since the date when Mr. Everard prepared his estimate.

The works at the source cost about 1,800*l.*, and those at the service reservoir about 2,800*l.*

## Water Regulations and Charges.

The following abstract from our water regulations may be given:—

1. All plumbers to be authorised.

2. All fittings to be tested and stamped by the Board, and only those marked "best" and bearing the maker's name are received.

3. Each house to have its separate communication pipe (unless otherwise authorised by the Board), except in the case of groups or blocks of houses the water rates of which are paid by one owner, or in case of stand-pipes in courts.

4. The Board at their own cost will lay communication pipes as afterwards described.

5. Services will be tested by water pressure before being permanently connected.

6. All pipes to be of lead if in contact with the ground or external to a house, but may otherwise be of best galvanised wrought-iron steam tube at the option of the consumer. All lead joints to be wiped joints.

7. Weight of lead pipes for high pressure:—

| Internal diameter of Pipe. | Weight of Pipe. |
|---|---|
| $\frac{3}{8}$ inch | 5 lb. per lineal yard |
| $\frac{1}{2}$ " | 6 " " |
| $\frac{5}{8}$ " | $7\frac{1}{2}$ " " |
| $\frac{3}{4}$ " | 11 " " |
| 1 " | 16 " " |
| $1\frac{1}{4}$ " | 20 " " |

Ditto for pipes having open ends:—

| | | |
|---|---|---|
| $\frac{1}{2}$ inch, internal diameter | .. | 3 lb. per lineal yard. |
| $\frac{3}{4}$ " " | .. | 5 " " |
| 1 " " | .. | 7 " " |

8. Every pipe to have a covering of 2 feet.

9. Drawing-cocks and stop-cocks to be of the screw-down kind.

10. No pipe to be connected directly with a boiler or rain-water cistern.

11. Every cistern to be covered and provided with a ball tap.

12. No waste pipes other than warning pipes allowed.

13. Every water-closet cistern to have an efficient waste-preventing apparatus, to discharge not more than two gallons of water at each flush. Urinal cistern, one gallon.

It appears that a Local Board has no means of enforcing its water regulations in some particulars; indeed, a case has been brought under the author's notice where a Local Board withdrew theirs altogether by reason of this deficiency of power. We find no difficulty at all, however, in enforcing our regulations.

Houses under the rateable value of 40*l.* are not allowed to have a larger pipe than ½-inch.

The Board lay and undertake to maintain all communication pipes from the main to within one foot of private property adjoining a street; and also provide and fix a stop-cock with iron cover, charging one shilling a year rent for the same. The Board's workmen open the ground, tap the main, and do all the necessary work of the connection: a plumber providing, laying, and jointing the service pipe, for which the Board pay him at the following schedule:—

| | | | *s.* | *d.* | |
|---|---|---|---|---|---|
| Providing and laying | ½-inch pipe | .. .. .. | 0 | 6 | per foot. |
| " " | ⅝ " | .. .. .. | 0 | 7½ | " |
| " " | ¾ " | .. .. .. | 0 | 11 | " |
| " " | 1 " | .. .. .. | 1 | 4 | " |
| Making wiped joint to | ½ " | .. .. .. | 1 | 0 | each. |
| " " | ⅝ " | .. .. .. | 1 | 0 | " |
| " " | ¾ " | .. .. .. | 1 | 6 | " |
| " " | 1 " | .. .. .. | 1 | 6 | " |

Water for fire purposes within factories being free, the Board make a charge of 5*s.* per quarter for inspection of the appliances. All private fire hydrants are sealed by the Board, a fine of 10*s.* being made for every seal broken.

Owners of small houses are allowed to compound for the water rates upon entering into a stamped agreement.

With a view to encourage persons to take advantage of the new supply, the water charges are fixed at the following low rates:—

5*l.* per cent. per annum on the rateable value of premises above the annual value of 8*l.*

1½*d.* a week for cottages not exceeding 4*l.* rateable value.
1¾*d.* ,, ,, ,, 6*l.* ,,
2*d.* ,, ,, ,, 8*l.* ,,
Fixed baths, 5*s.* each per annum. W.C.s, free.

Horse or carriage, when kept for sale or hire, or by a common carrier, 4*s.* each per annum.

For the use of water by a hose or flexible tube for garden or other purposes, 10*s.* each per annum.

For every standpipe, tank, or tap used for horticultural purposes, in a garden belonging to a house for which water rent is paid, in addition to the charge for a hose, 10*s.* each per annum.

For every standpipe, tank, or tap used for horticultural or field purposes, in a garden or field not belonging to a dwelling-house for which water rent is paid, in addition to the charge for a hose, not less than 1*l.* per annum.

Factories, by meter, at the following charges:—First 25,000 gallons per quarter, 1*s.* per 1,000 gallons. Each additional, up to 50,000 gallons per quarter, 10*d.* per 1,000 gallons. Thereafter, 8*d.* per 1,000 gallons.

The Board charge an annual rent on meters of 20 per cent. on cost.

Water for building purposes, slaughter-houses, and the like, by special agreement, based upon the meter charges.

All special agreements are terminable at six months' notice in writing.

It may be mentioned that the stop-cock provided by the Board is placed either on or outside private premises, as may be desirable. Winn's stop-cocks, with Waldron's wrought-iron stop-cock boxes, are used. A 6-inch common tile drain pipe on end is often used, instead of brickwork under the boxes.

Our tap-testing apparatus is a simple one. To a wooden lead-lined bench is fixed a cast-iron tubular bracket, to one side of which is bolted a patent tap-holder, and on the other[1] a brass hollow male screw, a flexible tube with union connecting it with a Tangye's boiler tester, which of course is provided with a pressure gauge.

Before drawing up our water regulations, the author wrote to different towns for information respecting several matters, the replies to which he has tabulated, in the hope that they may be interesting to some members of the Association.

| o you stamp .ll Fittings? | Bath. | Meter Charge per 1000 gallons per quarter. |
|---|---|---|
| , but allo ıpproved akers only | 4s. 5s. 5s. 6s. | From 1s. 6d. under 10,000, to 6d. over 500,000. |
| No. | . ; house bove 40l., he free. | From 1s. to 1s. 6d. |
| No. | .. | From 1s. under 5000, to 6d. over 500,000. |
| No. | 5s. | From 1s. 3d. under 20,000, to 6d. for 500,000. |
| No. | 5s. | 9d. |
| Yes. | in private | From 9d. to 5d. |
| No. | 10s. | About 2s. |
| No. | 7s. 6d. | Under 100,000, 8d.; above 100,000, 7d. |

| ... | Meter Charge per 1000 gallons per quarter. |
|---|---|
| ...den. | |
| ...greement. | From 1*s.* under 5000, to 6*d.* over 300,000. |
| ...r cent. on rate- | Under 50,000, 1*s.* 6*d.*; over 100,000, 1*s.* |
| | 1*s.* 6*d.* |
| ...ter. | Under 5000, 1*s.* 3*d.*<br>5000 to 20,000, 1*s.*<br>20,000 to 100,000, 9*d.*<br>Above, by agreement. |
| ... rood. | From 1*s.* under 1000 gallons a day, to over 5000 ditto, 6*d.* |
| ...: | |
| ...uare yards, 6*s.*;<br>...al 250, 2*s.* | 9*d.* |
| ...quare yards, or gallons. | 1*s.* 6*d.* downwards by arrangement. |
| ...hes, by meter. | From 1*s.* 3*d.* under 20,000, to about 5*d.* for 100,000. |
| | From 1*s.* 6*d.* to 1*s.* |

## DISCUSSION.

The PRESIDENT: Gentlemen, in opening the discussion I feel sure I am giving expression to your sentiments when I propose a very hearty vote of thanks to the readers of both these papers. With regard to the discussion, I propose that we should take first the paper of Mr. Fiddian on the sewage disposal works of Stourbridge. We have had the advantage with this paper of not only hearing it read, but also of having seen the works themselves. It is almost a pity in the case of the Market Harborough Waterworks that we could not have had a district meeting at Market Harborough, where we could have seen the works described in this very interesting paper. At the same time we are extremely obliged to Mr. Coales for having read this paper to us. We shall have it entered in our proceedings, and it will form an important addition to the valuable information we already possess in those minutes on waterworks. Passing to the paper on drainage there are several matters of extreme interest to us. A gentleman asked me to-day whether I did not think Stourbridge was rather a small place for a meeting of this Association, but I know all the members present, and all the members who are absent, will agree with me that in many small districts we find works of extreme interest to us. We have an instance of that to-day. We have seen works which are unlike other works in many places, and I know they have interested me greatly, and I am sure they have interested you in the same way. To take the paper more in detail, there are one or two points which strike me as interesting. I notice Mr. Fiddian says (see p. 113), "the Stanford joints which were used did not prove so satisfactory as to warrant their general adoption." That is a very important thing for us to know. Stanford's joints have been very often cried up, and have been used in many districts, and this is the first occasion on which I have heard of them failing. They may have failed elsewhere, and if any members can tell us whether they have found them to fail, or heard of them failing, it will be interesting to know of it. With regard to the pumping station the type of engine there used is a type I had not seen before. There was one point struck me with regard to the starting of the engine. It seemed very difficult, requiring almost a gymnastic performance on the part of the driver, who had to dodge about with a wooden lever before he could start it.

Perhaps Mr. Fiddian will be good enough to tell us whether that is usual. With regard to the feed-water being passed through a Green's economiser—one has heard a good deal of Green's economiser, and I was at one time thinking of having one myself, but abandoned it on hearing that the tubes required replacing very frequently, that they wore out, and that the machine consequently was *not* an economiser. Mr. Fiddian will tell us how long he has had his in work, whether the work has been done satisfactorily, and whether he thinks the life of the tubes will warrant his having introduced an economiser into his works. One other point, I notice Mr. Fiddian says that "probably the houses of about one-fourth of the population are supplied with water-closets." I want to know what becomes of the sewage of the rest of the population, and whether it is intended to add the remaining three-fourths of houses to the present system. Now we come to the rising main, and here we enter upon the most interesting part of what we have seen and heard to-day. I am referring particularly to the question of the siphon over the hill. I believe I am correct in saying the process which Mr. Fiddian has really invented is quite unique. When the paper was read it struck me I had not heard of anything of the kind before, and I got Mr. Fiddian to explain it more fully to us. I think we all understand it now after having inspected the works, and I think we can congratulate Mr. Fiddian on having been bold enough to introduce an apparatus which might not have answered, but which we are certain, after our inspection, answers its purpose of filling the siphon again after it is emptied, and preventing the air gathering on the top of it, very well indeed. I thought however, there was a possibility of the engine racing when the siphon began to work again, but it was apparent enough to us that there was nothing of the kind so long as the engine-driver stands by and sees that the engine does not race. I have one or two other matters upon which I should like to say a word. Mr. Fiddian speaks (see p. 117) of "the average observable effluent." We were not shown the effluent, and it is a very curious thing that we usually come away from sewage farms without having seen the effluent—it seems to be a way of effluents. Perhaps Mr. Fiddian will explain where the effluent does flow, and give us a little more information on that point. With regard to the expense of pumping this sewage, Mr. Fiddian works it out at the rate of 3*l.* per million gallons pumped. That comes to something less than ¾*d.* per

thousand gallons, and I think we can agree that is a very low cost. Now, just for one moment, passing to Mr. Coales' paper, the matter that is of extreme interest to all of us in that paper, among other matters, is the question of pipe testing. Now, as an engineer, I have myself carried out waterworks, and I was content there to have each pipe tested in the ordinary way on arrival at the works. The pressure was applied and the pipes struck by a hammer before they were laid, no further testing being required. No bursts occurred, and we had no trouble with them. The difficulty of testing them after they have been laid in the trench is the getting rid of the water after a burst or when the pipes are emptied, and Mr. Coales does not explain how he got rid of the water after the pipes had burst. That water must be run off somewhere, and it is a very great expense to pump it out. I have very great pleasure in moving that a very hearty vote of thanks be given to both these gentlemen for their interesting and valuable papers.

Mr. Eayrs: I have very great pleasure in seconding the vote of thanks proposed by the President to Mr. Fiddian, and also to Mr. Coales. I am sure we have all been very much interested and instructed by the papers we have heard read to-day. We have certainly very little time to go into the paper on the Water Supply of Market Harborough, but it will bear reading again, and very carefully perusing. There are several points in both papers of exceptional interest to the members of the Association, but in the case of Mr. Fiddian's paper we have had the advantage of seeing the works described, and therefore can fully understand the points raised by the author. There is one question I should like to put to Mr. Fiddian, and that is, as to the method adopted of getting rid of the subsoil water which leaked into the sewers. I notice that "before the completion of the works the water entering the sewers amounted to 150,000 gallons per day." By the means adopted he appears to have brought down the flow of subsoil water to 50,000 gallons, which is very considerable, and if he will explain the methods adopted, it will be of very great assistance. I understand that in Stourbridge there is a good deal of running sand to contend with, and I know there is very great difficulty in getting a watertight joint, even with the Stanford joints, in running sand. It appears that the volume of sewage from Stourbridge equals 25 gallons per head per day, and there is a further 3 gallons of subsoil water, I should like to know if the engines are capable of dealing with all the water in the case of heavy storms, as I presume

all the water which falls on to the roofs and into the back yards, flows into the sewers. The cost of pumping seems to be very reasonable, ¾*d.* per thousand gallons being very small for the amount of lift you have here. With regard to the effluent water it is a very common experience for members to fail to notice the effluent. The position of Stourbridge seems to be very much like that of Luton, where they have never seen any effluent. It disappears and nobody ever sees or hears anything more about it. Taking Mr. Coales' paper, I have very few observations to make. The number of pipes which failed after they were tested at the works and proved satisfactory, seems to be extraordinarily large. I have never tested pipes after they have been laid, but have been content to take them after they have been tested at the works, and my experience in some works which I carried out is that only two pipes failed in six miles after being laid. Consequently this number of failures, after testing at the works, seems very extraordinary. It is rather unfortunate that the firm who supplied these pipes happens to be a Stourbridge one; but I may say I have had pipes from this firm, and all they have delivered to me have been perfectly satisfactory.

Mr. A. T. Davis: I should also like to thank the authors of the papers for the very valuable information they have afforded us. With regard to Mr. Fiddian's paper there are just one or two questions I should like to ask him. I wish to know what type of automatic flushing tank is used at the head of the sewers, and whether the whole of the tanks which have been put down have answered their purpose satisfactorily. Then I notice that the ventilation of the sewers is by surface gratings. I should like to know if there have been any complaints from people who live near those gratings of offensive odours from the ventilators. With regard to the sewage farm, I think the Stourbridge Main Drainage Board is to be congratulated on having such admirable land for the disposal of the sewage, and having such a large area on which to dispose of it without having to resort to chemical treatment. The land is admirably adapted for the purpose, and seems to be very well situated. The farm is quite far enough away from the town, and I heard Mr. Fiddian explain, on the ground, that it is let to a farmer, who is not only able to deal with the sewage, but to dispose of the surplus to adjoining farmers on remunerative terms. In Mr. Coales' paper, I, like the other speakers, noticed the very large percentage of leaky and defective pipes, and must confess

to being much surprised at so many pipes failing after the first test. We usually trust to that first test, and it makes one think that the large amount of waste water in several waterworks is due to leaky pipes—with leakages which do not show themselves on the surface. It is a very interesting matter, and well worthy of consideration.

Mr. Godfrey: I should like, Mr. President, to endorse most cordially your suggestion that we should visit towns of small area and population, and I hope you will urge this upon the Council of the Association. There is many a bit of good work lost sight of by towns not being considered large enough for a visit by our Association.

The vote of thanks to the readers of the papers having been cordially carried,

Mr. Fiddian, in reply, said: I have to thank you, Mr. President and Gentlemen, for the remarks you have made upon the works you have visited to-day. I do not suppose for a moment that they are not open to a good deal of criticism, and I am sure I can see points in which—if I had to carry out the works again—I could make improvements. I will shortly answer the questions which have been put to me. First, as to Stanford's joints. The ground we had to use them in was chiefly running sand, and it is known to be very difficult to make a watertight sewer with Stanford's joints in running sand. I think my experience has been that of others. If I remember rightly, Mr. Parker, of Hereford, used them extensively at some works we visited last year, and did not succeed in getting watertight sewers. The difficulty in starting these engines is no doubt a disadvantage, but it was probably exaggerated to-day by a little nervousness on the part of the driver. I should certainly say it wants a man to be specially trained to the work before being placed in charge. Green's economiser is, I think, a valuable addition to any boiler plant. Ours has been working six years, and beyond the renewing of a scraper there has been nothing done to it. It saves a considerable amount of fuel, by delivering the feed-water at nearly boiling point with the use of waste heat only. The power required to work the scrapers is very small. Water closets are only partially used, most of the small houses having middens. I have no doubt, as time goes on, more water closets will be made, and we shall gradually reduce the number of middens; but at present there is no general movement in that direction. With

regard to the effluent, it was an oversight on my part that you were not taken to the outfall of the few drains we have. I inquired of the water man at the farm, and he told me there had been no effluent going away for some days. Frequently for two or three weeks at a time, when the under-drained portion of the farm is not being irrigated, there is little or no effluent water to be seen passing off the farm. Mr. Eayrs inquired what had been done to bring about the great reduction of subsoil water referred to in the paper. Where we found a great quantity of water coming in, the pipes were taken out and iron pipes put in their place. The bulk of our subsoil water came into the large tank sewers in the neighbourhood of the pumping station. These were built of 9-inch brickwork in cement, which proved to be far from perfect against subsoil water standing at a level of several feet over the crowns of the arches. We draw the water required for condensing out of the well at the back of the engine-house, and by this means have lowered the subsoil water level some feet, and so reduced the pressure and, to a great extent, the leakage into the sewers. The volume of the sewage in wet weather does not exceed the capacity of the engines except in heavy rainstorms. On such occasions the excess is passed by relief valves into the river at the bottom end of the town. The daily quantity on an ordinary wet day rarely exceeds 750,000 or 800,000 gallons. That we can comfortably deal with by one engine. We do not get much roof and backyard rainwater into the sewers, except in closely populated parts of the town. Very few of the rainwater pipes go into the sewers, but into cisterns. The flushing chambers are Doulton's. We have found them satisfactory, and they have all worked very well. As to ventilation we have had complaints, but those complaints have gradually died away. In a few special cases 6-inch iron shafts have been erected against houses, but what has done more than anything else to get rid of complaints has been systematic flushing. I have for some time past arranged for the flushing of every sewer in the town at least twice a week, and I believe that is one of the best means of preventing the bad odours sometimes experienced from street surface ventilating gratings.

Mr. Coales: I am very much obliged to you for the kind way in which the paper has been received. There is only one matter I will deal with now—that is the failure of a large number of pipes. The pipes were first loaded into barges on the canal, and then transferred to railway trucks, in which they were carried over

two lines of railways, and this may have had something to do with the large proportion of failures.

The President: Before we part I beg to move a vote of thanks to the Chairman of the Board of Commissioners for the kind use of this room. We have always been received most heartily in every town we have visited, and it has always been usual—and at the same time a great pleasure to me—to move a vote of thanks to the Chairman of the Board.

The vote was seconded by Mr. A. T. Davis, and carried with acclamation.

*During the day the members proceeded in brakes to the glass manufacturing works of Messrs. Thomas Webb and Son, where the members were afforded an opportunity of seeing the interesting operations of glass-making, cutting, engraving, and cameo engraving. They were also taken over the show-rooms, and shown the finished products of the firm.*

*The party thence proceeded in brakes to the Sewage Pumping Station (where light refreshments were provided), and from there to the Sewage Farm at Whittington, where the details of the arrangement for distributing the sewage over the land were carefully inspected, and their complete success admitted. The land is of a sandy nature, and readily absorbs all the sewage which is pumped on it—in fact the sewage has very largely increased, if it has not actually created, the value of the land for agricultural purposes. After a most careful inspection of the distributing apparatus at the farm, the members returned to the Town Hall for the discussion of the papers.*

*The members attending the meeting were subsequently entertained to luncheon at the Bell Hotel, Stourbridge, by Mr. P. Pargeter, Chairman of the Drainage Board.*

# DISTRICT MEETING AT HASTINGS.

**May 30th, 1891.**

*Held in the Council Chamber, Town Hall, Hastings.*

CHAS. JONES, PAST PRESIDENT, *in the Chair.*

THE Mayor, representing the Corporation, in a brief speech gave the meeting a hearty welcome to the city, to which Mr. Jones replied. The minutes of the last meeting in the Home District were read and signed.

The following paper was then read and discussed:—

## SOME OF THE PUBLIC WORKS OF HASTINGS.

BY P. H. PALMER, A.M. Inst. C.E.

I THINK, perhaps, before giving a description of some of the works which the members of this Association are about to visit, it would not be out of place to give a brief outline of the progress of the town during the last thirty years, and a few facts in connection with it as a first-class health resort.

Hastings is, as you are all doubtless aware, a town of considerable antiquity, and the immediate neighbourhood is associated with some of the most important and stirring events recorded in English history. The town furnished and fitted out a considerable number of ships to oppose the progress of the Spanish Armada, and at that time possessed a harbour of no mean size, the foundation piles of the entrance to which can now be seen at low water in close proximity to the eastern end of the Marine Parade. The harbour was destroyed by gales about the year 1590, and was never rebuilt; doubtless the loss was in some measure the cause of Hastings declining for many years afterwards, but it has during the last fifty years maintained

its reputation as the premier Cinque Port, and has, within the last thirty years, made rapid strides, and is now in the enviable position of being the second largest watering place in point of population in England; it also enjoys the reputation of being surrounded, on the land side, by some of the most picturesque scenery to be met with in the South of England, and has a sea view surpassed in extent by few watering places. The geological formation of the district is the Wealden, which is intersected and cut up by faults in a remarkable manner. The district (as might be expected when intersected by faults) is decidedly hilly.

The town of Hastings and St. Leonards has a sea frontage of a little over three miles, and a depth of from a mile and a half at St. Leonards to two miles at Clive Vale, and is divided into three distinct valleys, one at the eastern end of the borough, in which the old town of Hastings is built, one in the centre of the town commencing at the Memorial Clock Tower, near the Town Hall, and one at Warrior Square, which embraces the greater part of St. Leonards, all running in a northerly direction from the sea front. Hastings has a decided reputation of being one of the sunniest places in the British Isles, and during the year 1890 the duration of bright sunshine reached the large amount of 1746 hours. The mean temperature of the past year (1890) was 50·9 degrees at sea level. The resident population of Hastings in 1861 appears to have been about 20,000, and at the present time it is about 57,000. The increase in population for the last twenty years appears to be maintained at a tolerably regular rate. The area of the municipal borough is 2198 acres, and the rateable value 356,620*l*. The sanitary condition of Hastings has been improving for years, and the town has the satisfaction of being able to record the very low death-rate of 12·52 per thousand for the year 1890; this I think must be taken as a highly satisfactory state of things, considering the population of the town, and taking into account that a number of the residents are people who have attained to a considerable age, and have come to prolong their lives in the town; and I am strongly of opinion that, with the great advance sanitary science is making, this rate may be still further reduced.

The town of Hastings was entirely re-drained in the year 1866, and St. Leonards (then under separate jurisdiction) in 1887, and from that time till now the Local Authorities have been extending and perfecting the drainage system of the town. The whole of the surface water from the watershed, having an area of about 4200

acres, is admitted into the sewers, which are consequently of large size. There is a main sewer traversing each of the three principal valleys, discharging into an intercepting sewer running the whole length of the sea frontage. The sewage is run into two reservoirs, one at the extreme eastern end of the borough, at Rock-a-Nore, and the other at the west end of St. Leonards. The former has a capacity of about 1½ million gallons, and the latter of about 137 thousand gallons. The intercepting sewer is relieved during storms by means of storm water outfalls discharging into the sea.

A very large portion of the watershed area (about 2000 acres) is outside the borough boundary, and there is a population of about 15,000 inhabitants in the districts of Silverhill, Ore, and Hollington, which are contiguous to the town of Hastings and St. Leonards, but over which the Corporation exercise no control. The drainage of these districts, and that from the greater part of the watershed area, is discharged into the Hastings sewers.

The Hastings Rural Sanitary Authority has recently constructed a main sewer for the conveyance of the sewage of a part of Hollington and Silverhill, from which the greater portion of the surface water is excluded; this sewer is about two miles in length, one mile being laid with stoneware pipes, and one mile with concrete tubes, 24 inches in diameter. This sewer discharges into two sewage tanks about a mile to the westward of the west end of St. Leonards, which have been constructed by the Hastings Corporation, the expense of which has been partly defrayed by the Rural Sanitary Authority. In consequence of the position of these tanks and outfall being situated between St. Leonards and the growing township of Bexhill, and the difficulty of regulating the discharge of crude sewage into the sea, so as to avoid all risk of its not being taken by the tides clear of the fore-shore at the before-mentioned places, it was decided to precipitate the sewage and erect machinery for pressing the sludge. The site upon which these tanks are built is almost at sea level; the ground consists entirely of loose beach, which is charged by the sea at every tide. Each tank is 150 feet long by 16 feet wide and 12 feet deep, the foundations being 14 feet below high water level. The foundations are entirely constructed with cement concrete, the walls with blue brindled bricks laid in cement backed with cement concrete, and the roofing with iron joists and cement concrete jack arches. The sludge tank is 10 feet square, and is capable of holding about 4,000 gallons of sludge. The sludge is run through 6-inch pipes to two rams in the ram-well,

the bottom of which is about 30 feet below the engine-house floor, and 27 feet below high water. The ram-well is 8 feet in diameter, and constructed with cast iron cylinders bolted together in segments, the joints being made with thin strips of soft wood. The sinking of this well proved a most difficult piece of work, owing to the enormous amount of water to contend with and the bad foundation. After having gone through about 15 feet of beach, I came on to the original ground formation, and the remainder of the depth was sunk through the remains of a submarine forest, some of the trees being in a comparatively sound state. The cylinders were bedded on a floor of thick York stone, and filled in with cement concrete for a thickness of 2 feet. The sludge rams were then lowered into position, and concreted in to a height of 4 feet. The surface of the concrete was then rendered to falls, and a small hole about 12 inches square and 9 inches deep left in the centre to receive any small leakage from the joints of the cylinders, which is run into the rams through a specially made valve, and ejected through the rams.

The plant for dealing with the sludge consists of two rams, 36 inches in diameter and 4 feet high, fitted with discharge valves and two filter presses, each having 26 plates 26 inches square. The rams and presses are entirely worked with compressed air by means of a 6-inch air compressor, attached to a 4 horse-power Atkinson's gas engine, fitted with self-relieving valves, and connected with an air receiver having about 100 cubic feet capacity. The plant is fitted with all necessary valves, gauges, &c., and is a good specimen of first-class engineering work. It was manufactured by Messrs. Manlove, Alliott & Co., of Nottingham.

In connection with the works is a large shed for drying the cakes after they have come from the presses. It is 79 feet long by 19 feet wide, and has two large flues, covered with iron plates, running round the building, which lead from two furnaces at one end of the building. These furnaces are fitted with air jets to increase the draught, so that any refuse can be burnt. The sludge pressing plant is working very efficiently and is easily managed by two men, the various appliances actuated by compressed air making the work very light.

There are within the municipal borough about 65 miles of public roads, about four-fifths of which are well curbed, channelled and paved.

The subject of road-making is one which I cannot do more than

simply allude to here, but it is one which is particularly important in Hastings, owing to the difficulty of obtaining good metalling at a reasonable cost, and the damaging effect of sea water with which they are watered. I have however, made some trials of Cherbourg granite, which have turned out so satisfactory that I intend to use the material largely upon the principal roads in this town. The majority of the roads in Hastings are metalled with a local stone, which certainly does not stand well where there is any great amount of traffic; consequently, the amount of scavenging required is heavy.

The action of salt water upon the roads has proved to be most injurious, and after two or three weeks of fine weather, when it has been necessary to water them daily, the road is coated with a crust of salt. The effect of this is that as soon as the atmosphere becomes at all damp, the salt acts like a wet blanket on the road, and causes the surface to come up in large patches. It is then always necessary to wash and thoroughly scavenge the road.

I will now briefly allude to a subject which is one of great importance to Hastings, viz. its sea defences, and upon which large sums of money have been, and are being, spent. The sea wall or esplanade in front of the town extends from the Fishmarket to the west end of St. Leonards, a distance of nearly three miles, and is, on the whole, a sound and well constructed sea wall. The study of the travel of beach, the causes of the periodical denudation of certain portions of the foreshore, and the action of the tides, is a very interesting one, and upon which there is a considerable diversity of opinion among engineers. During the last few years denudations have taken place at the western end of the borough to such an extent as to cause several portions of the sea wall to collapse, in consequence of the foundation being beach, from which by the action of tides, the sand has been drawn away, and allowed the wall to subside and break up. In order to be perfectly safe against the action of tides and scour, it is essential that the wall should be taken on to a good foundation, and now I am engaged upon constructing an outer wall about one-third of a mile in length, which is being taken down to the rock in order to maintain the existing sea wall free from accident.

The wall, which is being built of cement concrete, is carried down to a depth of about 18 feet below high water level, and 30 feet below the esplanade, and is being faced with Cherbourg granite spalls.

The amount of water to contend with is so large that it is necessary to provide large pumping power, and an absolutely watertight subsoil drain. The pumps consist of 8-inch centrifugal, one No. 3 Woodford pump, and one No. 6 pulsometer, the combined discharges from which amount to about 330,000 gallons per hour. The subsoil drain is laid with stoneware pipes fitted with Hassall's patent joints, which have proved to be of great service, as I have no difficulty whatever in making a perfectly watertight joint even under water. This is of great importance, as it is essential to exclude all water from the pump well, except that which makes in the lengths of trench actually being worked.

There are fifty-three groynes along the foreshore, between Rock-a-Nore at the east, and Grosvenor Gardens at the west, which are, with the exception of three, entirely constructed of timber. The two groynes opposite the destructor works at Rock-a-Nore are constructed of cement concrete faced with granite and local stone. The groyne opposite the east side of Warrior Square is constructed of cement concrete faced with blocks made of fine cement concrete and hand-picked land flints, the face being finished with a raised struck joint. This groyne, which has now been built about twelve months, is 260 feet in length, and has accumulated a large amount of beach against it.

The Corporation carry out the greater part of the work in connection with repairs to the various pumping engines, machinery, and general work of the town with their own staff, as well as the shoeing of a stud of forty horses.

The works are attached to Filsham pumping station at St. Leonards, and comprise a smithy and store about 75 feet long and 20 feet wide, a turning and fitting shop 40 feet by 26 feet, and engine and storehouse.

The machinery in the turning shop consists of a 10-inch and a 6-inch centre self-acting double geared, sliding, surfacing and screw-cutting gap lathes, a 30-inch self-acting double-geared pillar drilling machine, a self-acting planing machine, to take in 3 feet by 20 inches wide by 18 inches high; a single-ended punching and shearing machine to punch ¾ inch holes in ¾ inch plates, and to shear up to ¾ inch thickness; and a pair of emery grinding wheels. In the smithy there are two smiths' fires, supplied with draught from a small fan, which is worked by a small steam engine, about one horse-power, a small reverbatory furnace for making brass and gun-metal, &c.

The power required for driving this machinery is derived from a six-horse (nominal) high pressure semi-vertical steam engine, steam being taken from the main boilers at the pumping station.

The staff consists of two smiths, two labourers, one fitter and turner, and two apprentices.

I find this shop extremely useful, and is the means of saving the town about 400*l.* a year on the repairs necessary to the many and various appliances used by a Corporation, in the Surveyor's and Water Departments.

The vexed question of collecting and disposing of the house refuse has from time to time engaged the attention of the Local Authorities, and in October 1888, it became necessary to seriously consider the best means of disposing of the dust-bin refuse collected in the borough of Hastings. Prior to this time it had been deposited in the yards of local brickmakers until they became glutted with the material, and it was found unprofitable to screen it in consequence of the competition of various kinds.

A committee of the Town Council was deputed to visit towns and inquire into the working of the various methods then in vogue of destroying the dust-bin and other refuse, and after visiting most of the towns in England where refuse destructors are at work, came to the conclusion that the apparatus known as "Fryer's" destructor and manufactured by Messrs. Manlove, Alliott & Co., Limited, of Nottingham, gave the best results.

It was then decided to build a four-cell destructor, with all the latest improvements, together with a "Jones" fume cremator, which is also manufactured by the same firm. The refuse destructor has four cells or furnaces, each capable of burning nine to ten tons of refuse per day of 24 hours. The heat and gases generated from the combustion of the refuse are passed through a cremator after leaving the main flue, and then through two steel multitubular boilers of 30 horse-power each, to the chimney shaft. The chimney shaft is 130 feet high above ground level, and octagonal in plan, and for a height of 30 feet from the ground line is lined with fire bricks, which has a cavity of 4½ inches, ventilated to the outer side for the purpose of always maintaining the outer work of the shaft perfectly cool. The base of the shaft is continued below the ground line for a depth of 30 feet, and carried on to a foundation of solid sandstone rock, and is constructed of cement concrete, which is upwards of 23 feet square, and contains about 330 cubic yards of concrete. The concrete was filled in con-

tinuously until completion, and is therefore practically a monolithic mass. Step irons are built inside the shaft from bottom to top, and the shaft is protected with a copper tape lightning conductor with rod and crowsfoot 7 feet above the cap. The whole of the flues and furnaces are lined throughout with fire brick.

The destructor, boilers, &c., are built over the sewage tank; the foundation of the shaft is taken through the tank and below the bottom of it, and the arches of the tank have been considerably strengthened under the whole site of works. The steam generated in the boilers is employed for driving a high pressure horizontal engine, which works the pumps and rams for raising the whole of the salt water used in the borough for street watering, sewer flushing, and the supply to private establishments. The water is raised to the reservoirs at three different altitudes, the highest being situated at Halton, about 270 feet above the engine house floor, and when pumping to this reservoir the engine is working up to 35·7 indicated horse-power.

By using the waste heat from the destructor I have been enabled to entirely put out of use the two Lancashire boilers which were used for generating steam for salt water pumping, which has saved an annual cost of about 200*l.* for coal.

The steam generated in the destructor boilers is also used for working a Washington-Lyon's steam disinfecting apparatus, of which Messrs. Manlove, Alliott & Co. are sole makers. This apparatus is situated at a distance of about 100 yards from the destructor, and steam is supplied to it at a pressure of 40 lb. to the square inch. It consists of an elliptical iron chamber having a steam jacket all round it, into which steam is first turned, in order to bring the inner chamber up to a sufficient temperature to prevent condensation when the steam is turned into it. The steam is then turned into the inner chamber, in which the infected articles have been placed, and they are subjected to a pressure of 30 lb. on the square inch, which gives a temperature of 273° F. The steam is then shut off from this chamber but left on in the jacket. This prevents any risk of the goods being damp, as the inner chamber is immediately turned into a drying cell.

The rapidity and efficiency with which the operation of disinfecting a large quantity of infected goods is carried on must be seen to be really appreciated, and this system is undoubtedly a long way superior to any yet in use in this country for effectually destroying infection or insect life in any material whatever, and is

moreover a process which does not in any way injure the most delicate coloured goods.

The town refuse is carted up an inclined roadway to the charging floor above the cells, which are fed from time to time. The fumes from the destructor furnaces pass into a main flue, and thence to the cremator, the temperature of which is about 600° F. when leaving the main flue of the destructor; they are then passed over a very fierce coke fire in the cremator, and are raised to upwards of 1,500° F. It is practically impossible for any gases to withstand so great a heat, and practical working shows beyond doubt that as long as the cremator is kept properly at work no smell of any kind and only a very slight amount of the white smoke is emitted from the chimney shaft.

The residue from the continuous day and night combustion consists of about 15 per cent. of good hard clinkers and sharp fine ashes, both of which have a high commercial value and are invaluable for forming the foundations of roadways and footpaths, as well as being capable of being used in many other ways.

I am fully convinced that the burning of the town's refuse by this method is the readiest means of disposing of it, and that the process is an economical one, as can be gathered from the annexed statement of the cost of working the destructor for twelve months. The waste heat can be used for generating steam, which can be applied to various uses in connection with the many works incidental to the requirements of the town authorities.

Cost of Working the Destructor for Twelve Months.

| Dr. | £ | s. | d. |
|---|---|---|---|
| To Wages, year ending December 25th, 1890 .. | 410 | 17 | 9 |
| „ Materials .. .. .. .. .. .. .. .. .. .. .. | 148 | 2 | 1 |
| „ Ditto from stock .. .. .. .. .. .. .. .. .. | 9 | 10 | 2 |
| „ Own cartage .. .. .. .. .. .. .. .. .. .. | 1 | 7 | 3 |
| | £569 | 17 | 3 |
| | 300 | 18 | 6 |
| Net cost of working destructor for twelve months | £268 | 18 | 9 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| By Amount received for sorting .. .. .. .. .. | 27 | 6 | 0 |
| „ Value of clinkers and ashes used on roads .. .. | 40 | 17 | 0 |
| „ Ditto ditto, sold .. .. .. .. .. .. .. .. .. .. | 12 | 15 | 6 |
| „ Value of steam supplied for salt-water pumping .. | 200 | 0 | 0 |
| „ Ditto ditto, for disinfector .. .. .. .. .. .. | 20 | 0 | 0 |
| | £300 | 18 | 6 |

There are other matters which would doubtless be of interest if time permitted me to dwell upon them.

The question of water supply to the town is one upon which much might be said, but I do not, however, propose to touch upon it now.

The town is possessed of a large public park and gardens, as well as two large hills at the east end of the town, known as the East and West Hills, the combined area of which is about 186 acres. They are tastefully laid out and much appreciated by the inhabitants.

I will conclude my remarks by saying that Hastings is a very healthy, well-looked-after town, and one which surpasses almost every other large watering place in the country for natural beauty and climate.

The essayist resumed his seat amid loud plaudits.

## DISCUSSION.

Mr. T. De Courcy Meade: The cost of dealing with house refuse in Hastings certainly appears to be very satisfactory. I have visited most of the towns in this country where a destructor is in use, and I do not know any place where the refuse is treated at such a small cost as we are told it is at Hastings. Perhaps Mr. Palmer will supplement his paper by giving us the weight of the refuse treated. A load is a very varying quantity, and I would like to have the weight in tons. If Mr. Palmer will give us the gross cost per ton of dealing with the refuse, it would help us to form a better judgment. I would also like to know if the outlying districts contributed to the cost of the sewage works. With regard to the watering of the roads with salt water, I visited Bournemouth a short time ago and heard it spoken of very highly; I was informed that it produced no injurious effect on the roads, but probably the materials of which the roads are composed have a good deal to do with it. If flints were used, instead of granite, it is possible that the result would be much better. I would also like to hear from Mr. Palmer whether he experiences any difficulty in drying the clothes after removing them from the disinfector. I notice Mr. Palmer works his disinfector at a steam pressure of 40 lb I have a Lyon's disinfector, but I cut off the steam at 25 lb. pressure, and I have found that considerable

time is then occupied in drying the clothes. After the steam has been removed from the inner cylinder we have to keep it in the outer cylinder for two hours, owing to the condensation which sets in when the atmosphere is admitted to the goods. In order to avoid this we now remove the clothes at once to the drying cylinder for the purpose of drying. I have recently erected a second disinfector, the "Nottingham," free from this objection. I quite agree with Mr. Palmer as to the value of the clinker refuse from the destructor. In my own district I could sell ten times the quantity of clinkers I now have at my disposal at a very good price indeed. I will conclude by moving a vote of thanks to Mr. Palmer for his interesting paper.

Mr. W. Weaver: I have much pleasure in seconding the vote of thanks to the author of this interesting paper. The only portion of the paper I will touch upon is that dealing with street watering. There seems to be a great divergence of opinion as to the value of salt water for road watering. I know there are several towns along the coast where large sums of money have been laid out in order to use the sea water for the roads, but if the Surveyor of Hastings is of opinion that it is injuring the roads, it becomes a question whether he is not losing more money by the system than he is saving by reserving the fresh water. I know twenty years ago in my own district at Kensington, and also at Westminster, a patent system of watering the roads with salts mixed with the water (the invention of an American) was tried, but at Kensington we found that the macadam roads turned up like peas, from the binding material being affected. I would suggest to the surveyor whether it would not be well to consider the system of using tar granite for his roads. At Cheltenham, a fortnight previous, a very interesting paper on tar granite roads was read by Mr. Hall, who spoke very highly of them, and produced facts and figures which, if correct, show that tar is a very useful addition to macadam roads. If you heat your tar, and coat it on your roads before rolling it in, I think you need have no fear of sea water turning them up as at present, and you will save something like 200*l.* a year on the pumping. I think I gathered from the paper that each cell of the destructor deals with nine or ten tons of refuse each day. That seems a very high average, though possibly it accounts for the small cost entailed in the annual working. Of course, the refuse of each town varies, and perhaps in this district the stuff thrown into the dustbins is drier and burns more readily than in many other places.

A vote of thanks was unanimously passed to the Mayor for the use of the Council-Chamber and for the cordial welcome which the Association had received at his hands.

*At the invitation of the Mayor, the Members of the Association attending the meeting were entertained to luncheon at the Eversfield Hotel, St. Leonards. The Mayor presided, and most of the members of the Corporation were also present.*

*The party then proceeded in brakes to the Sewage Precipitation Works at Bopeep. On the arrival of the party at Bopeep, the Mayor formally declared the works open, and started the machinery.*

Mr. P. H. Palmer then explained the machinery and the purposes for which it had been erected. The plant, he said, of the works you have inspected has been put down to deal with the sewage of a rural population of 6000 or 7000, but which, it is expected, will considerably increase during the next few years. It is simply the ordinary plant, the patentees and manufacturers of which are Messrs. Manlove and Alliott, of Nottingham, and is well known to all of you. The boilers are worked with compressed air and are capable of turning out half a ton of sludge at each press. We shall not turn out more than 45 tons of sludge a week at present, but the quantity will increase in time. We are trying ferosone, but I do not propose to continue its use. I think lime, at all events for our purposes, where we do not require a very good effluent, will be sufficient. These works were put down by the Corporation of Hastings for the outside districts, for which they pay us a rate of 2*d.* in the pound, which comes to something less than 50*l.* a year. At the present time this is not sufficient to pay the wages of one man to look after the plant. The cost of the sewage tank was about 3000*l.*, towards which they contributed two-thirds of the cost.

*The party then proceeded to the Filsham Waterworks, which were inspected, the members present expressing unqualified approval of the arrangements. The members were shown over the repairing shop, which is an idea of Mr. Palmer's. That gentleman explained that it is used for all manner of repairs, and he was able to confidently state that it has effected a saving of* 35 *or* 40 *per cent. to the Corporation through doing the work themselves. They had two fires and a smithy, and he had*

*sufficient work to keep them constantly employed. He looked upon that repairing shop as a pet scheme of his own, and he was sure that if other towns set up similar workshops they would never regret it.*

Mr. JONES said: I think it is only due to Mr. Palmer to express my opinion of the value of his work. I think this repairing shop is one of the most important adjuncts to any Corporation works. I have endeavoured in Ealing to do something of the kind, having my own smithy and forge, and I can speak as to the enormous saving which is effected by doing your own work. I know that for a time it creates some feeling among the local tradesmen who have previously done the work, and the surveyor has to bear the brunt of that; but it eventually wears off, and they come to feel that he is only doing his duty to the Corporation.

Mr. NORRINGTON: I should like to corroborate as to the advantage and value of doing your own work. I have recently started a somewhat similar workshop, where I have all my own shoeing done. I find it saves time, and it prevents mischief arising to the horse's feet.

Mr. PALMER explained that he was induced to set up the workshop from the fact that there were no engineering works in Hastings until quite recently, and when repairs were wanted to be done, the nearest place to which they could send work was to Rye, or to London, and very frequently the expense of carriage came to more than the cost of the work.

Mr. GARRETT corroborated as to the value of Corporations doing their own work.

Mr. T. DE COURCY MEADE also added his testimony as to the value of a Corporation workshop. He did his own shoeing, and not only did he find that the horses were better shod, but he saved time in frosty weather. Last winter not a single horse left his stables more than five minutes late.

Mr. A. J. BROOKES felt there could be no two opinions that an engineer who had his own workshop was in a much better position than one who had no workshop, not only for facilities of doing work, but for reasonableness in the cost of carrying out repairs.

The members then looked at the pumping engines, which Mr. Palmer explained were of high and low pressure 100 horse-power nominal each. They pumped up to a height of about 260 feet above

the floor level. He was sorry they were not at work; but they had done their day's pumping, as the town had an intermittent supply. The engines he found to be an exceedingly good type of pumping engine. He had cut off the high pressure cylinder of one of the engines, and was using it as a low pressure condensing engine for a lower lift. Generally speaking they only pumped to a lift of 114 feet, and he thought they would be able to do that with a low pressure cylinder, and a consequently large saving of fuel. The depth of the well was 76 feet; the total amount pumped in twenty-four hours was one million gallons, which represented rather more than sixteen gallons per head of the population. He knew very few towns where the consumption was lower. Water was a very valuable commodity in Hastings, and was very carefully looked after. They had Deacon's waste meters and a staff of inspectors to watch the consumption.

The MAYOR: As the town has doubled in population in twenty years we shall naturally have to make proper provisions for the constantly increasing demand.

MR. PALMER: You cannot get over the natural difficulties of the district. The geological formation is the Ashdown sand intersected with faults, with Fairlight clay underlying it. It is impossible to get any large quantity of water at any one point. As the Mayor has said, the town has doubled its population in the last twenty years, so that there is every prospect of our having to look about for a fresh supply of water at no far distant date.

*The members then drove to the works of construction of a new sea wall at St. Leonards, and from thence to the refuse destructor under the East Cliff, where the various appliances, including the disinfecting apparatus, were inspected, the small cost of destroying the refuse being again most favourably commented upon by the members present. At the conclusion of the inspection a hearty vote of thanks was accorded to Mr. Palmer for the visit.*

# DISTRICT MEETING AT NORWICH.

**June 13th, 1891.**

*Held in the Council Chamber, Guildhall, Norwich.*

O. C. Robson *in the Chair.*

In the absence of the Mayor of Norwich, the Deputy Mayor (Mr. W. H. Dakin) very cordially welcomed the Association to the town. Mr. Buckham was unanimously re-elected Honorary Secretary for the Eastern Counties District. It was announced that Mr. Marshall, the City Engineer, who had undertaken to read a paper on the Works of Norwich, was ill, and unable to carry out his intention.

The following paper was then read and discussed:—

# PORTLAND CEMENT—SPECIFICATIONS AND MODES OF TESTING.

By H. K. G. BAMBER, F.C.S., Dovercourt, Essex.

## Testing Portland Cement.

The author has had the honour of being asked to read a short paper before you on Portland cement, a material which of late years has come into use for building purposes in all kinds of marine and land work, and which has been employed with great success, although occasional failures have resulted, either from ignorance in the use of the material or carelessness and inattention in the manufacture of the same, which fault, however, it is quite possible to discover by proper modes of testing before using the cement.

To insure having a good article supplied to them, engineers,

surveyors, and other large users of Portland cement, have of recent years compiled various specifications for the manufacturer, containing many and various tests, to which the cement has to be submitted when supplied to the works by him, and it is on these various clauses in specifications, and the usual mode of testing that the author would like to make a few remarks. Before entering into a contract, a Portland cement manufacturer requires and is generally supplied with one of these various specifications by the contractor or engineer, in which is stated the different tests to which the cement will have to be submitted and pass to insure it not being rejected and thrown back on his hands.

The first clause that is met with in almost every specification is, that the cement shall weigh a certain number of pounds to the "striked bushel." Various specifications state different weights, generally however ranging from 110 to about 116 lb., this test being inserted, as is imagined, to insure the cement being properly and heavily burned.

Now this test is altogether a delusive one; in the first place it gives no information as to the quality of the cement, and is a test which varies greatly with the age of the material. Then again it is a test that can be made to show many and conflicting results with the same cement, depending greatly upon the manner in which the test is made and upon the wish and interest of the manipulator.

For instance, a quantity of cement poured into a bushel measure down a smooth board set at an angle of 45°, by a man accustomed to his work, and struck off level, weighed 114 lb. exclusive of the weight of the measure. A second portion of the same cement was then poured slowly out of a sack into a bushel measure and struck off level; it then weighed 118 lb. A third portion of the same cement was poured into a bushel measure as in the first instance, down a board at an angle of 45°, the man making the test not being sufficiently careful to avoid disturbing the bushel measure during the operation of filling, thus showing when weighed a much higher result, it being then 117 lb. to the bushel. Another portion of the same cement was then shaken down in the measure and then showed a weight of 134 lb. to the bushel. When it is found therefore that, with the same measure of capacity, and with the same cement, there can be a variation of from 114 to 134 lb. per bushel, such a test is proved to be without any value, and cannot be relied upon as showing

with any certainty that the cement is one that has been properly burned. Then again, as to the loss of weight per bushel by age; a cement if weighed when cool, a few hours after being ground, and then allowed to remain exposed to the air, will be found, if, weighed from time to time, to be gradually losing weight per bushel for several months, especially so if it remains in a place where a free current of air is continually passing over it. The following experiments of the weight per bushel of several cements at different ages which I have made are interesting and conclusive:—

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|---|
| Weight when ground.. .. | 116 | 118 | 117 | 116 | 119 | 116 | 118 |
| „ in fourteen days .. | 114 | 113 | 116 | 115 | 116 | 115 | 115 |
| „ in one month.. .. | 111 | 112 | 113 | 111 | 114 | 113 | 114 |
| „ in two months .. | 106 | 109 | 110 | 110 | 109 | 110 | 112 |
| „ in four months .. | 105 | 109 | 105 | 106 | 108 | 106 | 109 |
| Percentage loss in four months .. .. .. | 9·48 | 7·62 | 10·25 | 8·62 | 9·16 | 8·62 | 7·62 |

The above experiments show that a cement loses weight per bushel by age, slowly and continuously, to the extent of 8·76 per cent. in four months, taking the average of the seven experiments, and this loss will be the more marked in a cement containing any considerable quantity of free lime in its composition.

Then again the weight per bushel depends a great deal upon the fineness to which the particles of cement have been reduced by grinding; the finer the cement—and therefore a more valuable material—the less it weighs per bushel; and therefore to ask for a very heavy cement is as good as asking for a coarsely ground one.

This test then, showing such liability to variation, is the cause of much trouble when enforced, both to the manufacturer and the consumer. For instance, an engineer or contractor orders from a manufacturer some cement in accordance with some specification which is to weigh say 112 lb. to the striked bushel, stating nothing as to when the test is to be made. The manufacturer makes the cement under this order, and which when new, say one or two days after being ground, weighs 116 lb. to the striked bushel, and therefore in excess of the requirement of the specification; it is then shipped to some distant port, or perhaps is kept in store by the manufacturer for some little time, the engineer or con-

tractor not being ready to receive it, or from some other simple cause of delay the cement is not delivered immediately. When, however, it is delivered, the engineer probably allows it to remain several days before making the test, and then finds that it does not weigh 112 lb. to the striked bushel as required by the specification, and consequently rejects it, although he has been supplied with a material which when made was much heavier than he required, and which has, as is generally supposed, improved by having been stored for some time. This causes a vast amount of annoyance both to himself and the manufacturer; to himself because he thinks he has not obtained the quality of cement he asked for, and to the manufacturer because he knows that he has really supplied a material even better than was required of him.

It will be seen from the above remarks that even an "expert" in cement testing, taking the weight per bushel as his guide, would be as likely to condemn a good cement which had been properly and heavily burned but which had lost its weight by age, as he would an inferior quality of cement which had been but lightly burned in the first place.

## Specific Gravity.

If instead of this delusive test of "weight per bushel" the "specific gravity" of the cement was insisted upon, a vast amount of trouble would be saved, as fineness of grinding does not affect it, and it is not liable to the variations shown above in the weight per bushel test, although of course it diminishes with the age of the cement, but not to so great an extent. The following examples show this:—

| | 1. | 2. | 3. | 4. | 5. | 6. |
|---|---|---|---|---|---|---|
| Specific gravity when new .. .. | 3·131 | 3·129 | 3·133 | 3·128 | 3 127 | 3·130 |
| " " in fourteen days.. | 3·122 | 3·122 | 3·126 | 3·121 | 3·123 | 3·126 |
| " " in one month .. | 3·112 | 3·106 | 3·113 | 3·070 | 3·102 | 3·100 |
| " " in four months .. | 3·022 | 2·969 | 3·001 | 2·994 | 3·006 | 3·010 |
| Percentage loss in four months .. | 3·481 | 5·113 | 4·213 | 4·283 | 3·869 | 3·833 |

Thus after four months the average specific gravity of the six cements has been reduced 4·132 per cent., compared to 8·76 per cent. loss of weight per striked bushel.

If however users of cement still continue to insist on the "weight per bushel" test, they should state at the same time the age the cement is to be when weighed.

### Grinding.

The second clause generally found in the specification is with respect to the degree of fineness to which the cement is to be ground. This of course is a practical test and one of great importance, the finer the cement is ground the greater its value for concrete work. I may mention that the average requirement is not more than 10 per cent. to 15 per cent. residue when sifted through a $50^2$-sieve, that is, one having 2500 holes to the square inch. Such residue, however, although the hardest and best part of the burnt "clinker," is of no more value in the cement than so much sand, but which if ground would greatly increase the strength and the commercial value of the cement. The demand for finely ground cement is however becoming more universal, and under several specifications I have frequently supplied cement ground so fine as to leave no residue whatever on a $60^2$-sieve, 3600 holes to the square inch, and a residue of only 10 per cent. by weight on a $76^2$-sieve, 5776 holes to the square inch. Such a cement of course has a much higher market value than a coarsely ground one, the residue and therefore useless material therein having been reduced to a minimum.

### Tensile Strength.

The next test generally required is the tensile strength per square inch area. This test is one of considerable importance as showing the quality of a cement if properly applied. It is, like the weight per bushel test, however, liable to many variations, depending entirely upon the will and experience of the manipulator. The author does not mean to say that a bad cement can be made to show a good tensile strength, but with it unfortunately a good cement may be made to show a very inferior result, which is another frequent cause of trouble between the manufacturer and the consumer. Unfortunately, the engineer generally leaves the working of this test to some subordinate, who is frequently utterly incapable of, and ignorant of the properties of cement and the care required in, making this test, with the result that in such hands

the tensile strength frequently obtained is far below the requirements of the specification, acting upon which result the engineer either makes a complaint to the manufacturer or in some cases rejects the whole batch of cement.

The manufacturer, however, whose reputation is at stake, justly refuses to remove the condemned cement until it has been tested to his satisfaction in presence of the engineer or his representative, with the almost invariable result, when the cement has been made by a manufacturer of good repute, that the engineer is bound to admit the fallacy of the original tests made by his subordinate, upon whose testimony he had condemned the cement. Cases like the above are of frequent occurrence, and as may be imagined cause a vast amount of unpleasantness between the engineer and the manufacturer, the former because he does not like to admit, which in justice he is bound to do, that he has made a mistake, the latter from the fact of his cement having been condemned, however unjustly, and thus discredit cast upon the name of his firm.

If then engineers, instead of depending upon tensile strain and weight per bushel, would specify the chemical proportions of the lime, and the "specific gravity" of the cement, they would get a much better and safer material, and would not be liable to the trouble and inconvenience caused frequently by the tests now in force. To obtain the high tensile strain now required by some engineers, a larger percentage of lime is introduced into the manufacture of cement than formerly, and great care has to be taken by the manufacturer that any considerable excess of lime is not present; but it may be stated that cement cannot be made containing *no* free lime, although in a well-made sample it can be reduced to a very small quantity.

An engineer therefore, to have any idea of the quality of the material he is using, should insist on the cement being of a certain fixed chemical composition, which in combination with the specific gravity would insure his obtaining a cement the strength and safety of which could be relied upon.

A cement containing not less than 60 per cent. and not more than 62 per cent. of lime, and having a specific gravity of not less than 3·1, one month after its manufacture, would be one capable of standing every test to which Portland cement is now subjected. The percentage of lime being kept within certain limits is a safeguard against it being over limed, and the specific gravity being insisted upon at not less than 3·1 would insure it being properly and

heavily burned. Such a cement will not blow, and will carry a tensile strain of from 400 to 500 lb. to the square inch after seven days.

For several years the author has made cement of this composition, which is recognised by eminent authorities on Portland cement to be a good and sound one. In over 300 tests for tensile strain made with this cement, taking an average of three briquettes for each test, he has not had one sample stand a lower strain than 400 lb. to the square inch, the average being about 430 lb. It is essential however that the specific gravity should always be required in conjunction with the fixed chemical composition, otherwise a cement the constituents of which may be in the proper proportions, may still be of inferior quality owing to its having been insufficiently burned.

If engineers therefore would adopt the following simple specification for Portland cement, and have the samples of the cement submitted to a competent and trustworthy analyst, they would get a material of one uniform good quality, and would not be subject to the annoyance now too often experienced with the usual modes of testing in the hands of inexperienced men.

### Specification—Portland Cement.

1. The cement shall contain not less than 60 per cent. and not more than 62 per cent. of lime, and not more than 1·75 per cent. of magnesia.

2. The specific gravity at any time within one month after being made shall not be less than 3·1.

3. The fineness to be such that there shall be a residue of only 10 per cent. by weight when sifted through a sieve having 2500 holes ($50^2$) to the square inch.

There are other tests sometimes inserted in specifications which are, however, of little importance, one clause sometimes met with is that "Pat samples half an inch thick shall be made and placed in water within an hour of being mixed, and shall show no signs of cracks within 48 hours;" followed immediately by another clause stating that "The cement shall not in any season of the year set in less than one hour."

These two clauses combined practically fix the setting-point of the cement at 60 minutes, for if it sets before the expiration of that time it is liable to be rejected, while on the other hand if it is not

sufficiently set in 60 minutes when it has to be immersed in water in accordance with the first clause, it is well known, that any cement, however well made and mixed up in thin pats as above, if placed in water before being properly set, will show signs of cracks. &c., in a very short time. As the setting-point of cement is extremely variable, a new cement setting in a much shorter time than one which has been exposed to the air for some time, the time of year, that is to say the weather, also having an appreciable effect on the set of cement, it will be seen that the manufacturer has considerable difficulties to contend with if he intends to meet the requirements of such clauses in specifications, if enforced.

With respect to the third clause in the proposed specification, of course it is a matter entirely for the engineer to determine how fine he wishes the cement to be ground, the value of the cement of course increasing with its degree of fineness.

## DISCUSSION.

The DEPUTY MAYOR: I wish to ask Mr. Bamber a question. I am at a loss to see how this specific gravity test can be accurate, inasmuch as Mr. Bamber has very abundantly shown that the measure test which preceded it is not reliable.

Mr. BUCKHAM: Mr. Bamber tells us he fixes the percentage of magnesia 1·75, but he does not give us his reasons for fixing it at that quantity. I should like him to state his reasons. I think this a very valuable paper, and one upon which there might be a useful discussion. Any one who has had to do with cement work can realise the difficulties referred to in Mr. Bamber's paper. There are many gentlemen present who have had a large experience of cement work, and who ought to be able to join in a general discussion of considerable value to members. There are two or three suggestions in the paper which I think ordinary engineers would experience a difficulty in working. Mr. Bamber, for instance, suggests that instead of the usual tests we give in our specifications, a chemical test should be applied. I think he is quite right in that, but I should like to ask him how we are to get these chemical tests made. We are not as a rule chemists, at all events of sufficient capacity to test the cement ourselves, and we might have to send samples a considerable distance for analysis, because to get proper analysis you must send them to a reliable man, or

the tests will not be accepted by the manufacturers. I think the difficulty as to weight might be got over if you specified that the cement should weigh a certain number of pounds per striked bushel at a month after delivery, or on delivery, or some other fixed time. It is always desirable that cement should have age before being used. For instance, in the case of a cement pavement, if you use a new cement the top will crack and shell off. As to grinding, a finely ground cement is the best, but we are told it is much lighter. That is a suggestion to us in making our specifications that we do not fix the weight per bushel at too high a standard. With regard to tensile strain it seems to me that we could not do without that test. The tensile strain, even with the chemical test, is a very easy and ready way of arriving approximately at the value of a Portland cement. But most of the members present have had practical experience, and they will be able to say whether that ready and easy test is not also a very useful one. Every engineer knows it is very desirable that a cement should have no free lime, because the tendency when there is any free lime is when the cement gets damp for the work to expand and burst. There are two very important things with regard to cement—it should not be new but aged, and there should not be too much lime in it.

Mr. Butler: I came here to listen and to learn, but there is one point which I noticed in the paper upon which I may be permitted to say a word or two. A great deal of discussion has taken place upon magnesia, and the danger of having too much magnesia in cement, because, particularly in sea works, the salt water has the effect of disintegrating the cement. But it has never been properly proved that the cement so acted upon was sound cement when set. Some years ago I was engaged in the manufacture of magnesia cement, and I found if the magnesia was heated to a degree greater than red heat it was spoilt, that is to say if you heated it to a heat as great as Portland cement to get a good clinker, you destroy the magnesia, which becomes inert and worthless. We found if we heated the magnesia to a white heat we could do nothing with it, as it was inert and very little better than sand. If the ingredients have a certain proportion of magnesia in them, and the cement is properly burnt, there is no danger to be feared from the magnesia. A chemist might find that there was magnesia present on analysis, but it would be no danger whatever to the work. With the rest of the paper I quite agree with Mr. Bamber, and endorse what he has said.

Mr. Walker: I have carefully read the paper, which would have been very valuable if the author had given the best way of testing the tensile strain. I know the difficulties with regard to the various tests, and have passed through what he says, but when there is only a small quantity of cement, and action has to be taken upon it quickly, the expense of sending it to a chemist for analysis ought to be avoided. I quite agree with Mr. Bamber as to the worthlessness of the large stuff got out of the cement, and if it were kept out altogether by being sifted at the works, and the coarse ground down again, it would be a cheap way of getting a better result in cement work. I have sifted a large quantity out, and tried to make briquettes of it, but it is perfectly worthless, as the briquettes made of it will neither set in water nor out of it.

Mr. O. C. Robson: I think, perhaps, the interest of the paper would be somewhat added to if Mr. Bamber would give us the results of his tests by tensile strain, together with specific gravity. I have lately carried out some tests, and I find with Mr. Bamber that although the weight reduces with age, the tensile strain increases. With regard to the grinding and fineness of the cement, there again, perhaps, I am not quite of the same opinion as many engineers. I think we rely to too great an extent upon the grinding. I have tested cement which has passed through a 2500 sieve, and also a 3600 sieve, and I find very little difference between the tensile strain of the two cements, although the expense of the one through the excessive grinding is very much greater. I don't quite agree with Mr. Bamber's statement (see p. 158) that the loose way in which the tests are conducted is a "frequent cause of trouble between the manufacturer and the consumer." I have now had many years' experience in cement, and the testing of it, and I have never had but one unpleasantness and one dispute, and that was got over in a very pleasant manner (and it seems to me the proper way for disputes of that kind), by referring it to an expert or professional tester—Mr. Faija, Mr. Stanger, or some other. In that instance I am happy to say my test was found to be correct. With Mr. Walker I think, if Mr. Bamber could give us the method of testing adopted by him it would be a very valuable addition to his interesting paper.

Mr. Silcock: The author fixes the percentage of lime at 60 to 62 per cent. which seems a very small margin indeed, and one in which any imperfection in the lime might make a very great difference. There is one test which has not been mentioned, that is

the compression test. Why the tension test is used and not the compression I do not quite know. I should like to ask Mr. Bamber if he has carried out any compression tests. The chemical test is a very valuable one, but we are more or less mechanical in our turn of mind, and I think we should have some mechanical test. There are two important tests—the mechanical strength of the cement, and the question whether it will blow or not. We can leave the question of weight and colour, as they do not affect us so much as the strength of the cement, and whether it will blow or not. Mr. Faija, in a paper read before the Institution of Civil Engineers, described an apparatus for testing the blowing. That is a very simple apparatus and one that can be applied by any engineer. He also described a mechanical mixer that almost puts the mixing beyond the point of skill. There is a great difference between the skill of two operators. I have known several occasions where a test has not turned out satisfactorily, and the manufacturer sent a man who has mixed new briquettes very much stronger. But there is practically no skill at all in mixing with Mr. Faija's apparatus. Therefore, I think we want these two tests: a mechanical test, the mixing to be done by a machine; and secondly a test for blowing, to be done in some apparatus similar to Mr. Faija's.

Mr. H. K. G. Bamber, in reply, said: With respect to Mr. Dakin's question as to the specific gravity test, of course the weight per bushel test and the specific gravity are both tests of weight and capacity. The specific gravity of a solid or liquid denotes the weight in grammes of one cubic centimetre of the substance, and the test is made in the following manner: An apparatus is used containing a glass tube graduated into cubic centimetres attached to a small reservoir below, which is filled with turpentine up to the lowest mark on the graduated tube; 100 grammes of cement are then accurately weighed to a milligram on a delicate balance, and then filled into the apparatus. The cement sinks into the turpentine and the oil rises in the graduated tube in proportion as the cement displaces the liquid. The number of cubic centimetres occupied by the 100 grammes of cement can then be read off on the graduated tube, and by a simple calculation the weight of one cubic centimeter (the specific gravity) can be determined. With care this test can be made so that the difference in several experiments on the same cement exists only in the third decimal figure. The risks of variations in filling the measure of capacity, as shown in the weight per bushel test, are in this way entirely avoided. In reply

to the remarks of Mr. Buckham and Mr. Butler, as to the amount of magnesia allowed by the specification, 1·75 per cent., I maintain that magnesia, when incorporated in cement, is a most dangerous ingredient. It finds its way into the cement in the raw material, the clay used generally containing from 2 to 3 per cent. of carbonate of magnesia. The heat employed in burning the cement is only sufficient to drive off the carbonic acid from the carbonate of magnesia, leaving it in the form of an oxide, similar to any free quicklime, but it is a much more dangerous material, for this reason: When the cement is gauged and mixed up as concrete, if a sufficient quantity of water is used, any small quantity of free lime that may be present in the cement becomes instantly slaked and expanded, and thus its dangerous property is expended before the concrete is placed in position. It is not so, however, with magnesia, which will not take up its water of hydration so quickly, but takes sometimes weeks, or even months, before it becomes hydrated, and when it does it expands with considerable force, and is likely to cause disintegration of the whole mass if any large quantity of magnesia is present. Some engineers think 3 per cent. of magnesia in cement safe, but as it is quite possible to make cement containing only about half that amount I should advise the smaller quantity, 1·75, being fixed as the limit. In reply to Mr. Robson's remark as to whether the tensile strength decreases in a similar way, and in proportion to the loss of weight per bushel, I may say that a cement which has lost its weight by age, and therefore an old cement, will be much slower in setting than a new cement, and would not reach its ultimate strength so quickly as the latter. Consequently, an old cement should not be expected to show so good a tensile strength as a new one in the early or seven days test, especially with the sand test, although eventually it will become equally strong. The results of the tensile strain obtained with over 300 samples of cement are given in the paper, and also the results of several experiments on specific gravity. Mr. Robson tells us that in the course of his experience he has only had one dispute with a manufacturer with respect to the tensile strength of a cement supplied, which affair, however, was amicably settled. I must say in reply to this that my experiences in this respect have been more numerous, and the result in every case has been in favour of the manufacturer, and in most cases the affair has been amicably settled, but I am sorry to say I have met exceptions. In reply to Mr. Walker, as to how the tensile strength

test should be made—in making this test there are several important points to be considered. Care should be taken that sufficient, and not too much water, is added. The quantity necessary can only be judged by practice and experience. The cement should be thoroughly mixed up, and as quickly as possible placed in the mould, where it should be left undisturbed until thoroughly set. Care should be taken in removing the briquettes from the moulds, and in fact the briquettes cannot be too carefully handled during the setting time allowed before testing. The presence of too much water, or an insufficiency of the same will cause a great discrepancy in the results of the tensile strain obtained. In reply to Mr. Silcock, I believe there is a machine for mixing cement for testing and I have no doubt it is very useful, but as I believe the cement after being mixed in the machine has still to be handled with a trowel, I for my part would be content to mix it entirely with the latter. I do not quite understand his remark with respect to the percentage of lime specified, but I can assure him with care it is quite possible to make Portland cement so that should a sample be taken from any part of the bulk, and at any time, the percentage of lime would be found to be within the specified limits, viz. not less than sixty per cent. and not more than sixty-two per cent. With respect to Mr. Buckham's remark as to the practicability of applying the chemical test in the ordinary way of business, I quite agree with him it would not be worth while for a person using a very small quantity of cement to go to the expense of having it analysed, but in this case the necessity might be avoided by obtaining the cement from a firm who would guarantee the chemical composition, as I think any manufacturer would be pleased to do who employs a resident chemist.

Votes of thanks were unanimously accorded to Mr. Bamber for his interesting paper, and to the Deputy Mayor for his presence and for the use of the Council-chamber.

*In the afternoon the members visited Norwich Castle, a fine specimen of Norman architecture, which has been used in recent years as a county prison, but is now being transformed into a Natural History Museum. The cells have been cleared out of the various buildings, which are octagonal in form, and by means of roof lighting, they are now converted into light, spacious, and well-*

*appointed rooms. The cost of the alterations amount to about* 12,000*l. The members were shown over the buildings by Mr. Beardman, the architect, and Mr. Eaton, the hon. secretary, who gave full explanations of the various works proposed to be carried out.*

*At the conclusion of the visit, Mr. Walker proposed a vote of thanks to Mr. Beardman, the architect, and Mr. Eaton, the hon. secretary of the committee, which was heartily accorded, and suitably acknowledged by those gentlemen.*

*The members also had an opportunity of inspecting the new sewerage works which are in progress in the city.*

# ANNUAL MEETING IN LONDON.

**June 25th, 26th, and 27th, 1891.**

## ADDRESS OF THE PRESIDENT,

MR. T. DE COURCY MEADE, M. Inst. C.E., F.G.S., F.S.I., &c., HORNSEY.

THE first duty which devolves upon me as your President is to tender my hearty thanks to you for having placed me in this distinguished position. I feel deeply the responsibility of presiding over an Association which numbers upwards of 400 members, all of whom are experts in one branch at least of the engineering profession. In accepting this trust, I look forward to receiving your cordial support in the discharge of the duties appertaining to the office, and I can assure you that my earnest endeavour will be to promote to the utmost of my power the welfare of the Association.

In looking through the sixteen volumes of the 'Proceedings,' I find that almost every subject of special interest to the Association has already been touched upon in the able and interesting addresses of my predecessors; in fact I have entered upon ground so well trodden that it is difficult to find new matter, and not lose sight of subjects which are still of as much importance and interest to us all as they were when the Association was first formed.

During the past year, the Association has been incorporated, and our body thus gains a recognised status. As the first President elected since the incorporation, it may not be out of place to refer to the progress made since the Association was formed.

It is now twenty years since our esteemed Past-president, Mr. Lewis Angell, M. Inst. C.E., the founder of the Association, invited a few gentlemen to meet at his office and discuss matters connected with the position of the local surveyor. Subsequent meetings were held in this building, resulting in the formation of this Association. The inaugural meeting, at which 33 members were present, took place here on the 2nd of May, 1873. From that time the Association has steadily grown in numbers and importance. In 1875

the total number of members, including 6 honorary members, was 170; in 1881, 204; and to-day we number 400. This increase is fairly satisfactory, and shows that the work of the Association is extending. It is, however, to be hoped that our recent visit to Scotland, and our proposed visit to Ireland, may be the means of bringing into the Association many additional members from those countries.

It is gratifying to note that many of those gentlemen who supported Mr. Angell in the formation of the Association are present, and are still constant attendants at our meetings. One of our past-presidents recently told me that he has attended every annual meeting of the Association since its formation, and while doing so has not been absent from any meeting of his Borough council or committee.

The Association now numbers amongst its members gentlemen holding public appointments in Canada, Australia, China, South Africa, and other countries, and I think I can assert, without fear of contradiction, that at the present time almost every town of importance in this country is represented in this Association by its municipal engineer. We have been gradually but surely building up the sanitary branch of the engineering profession, although our progress has not been so rapid as other and younger branches of that profession.

Since the rules of the Association have been revised, and county surveyors and surveyors holding appointments under the Metropolis Management Acts have become eligible for membership, many London gentlemen have joined the Association, but it is to be regretted that a larger number of county surveyors have not availed themselves of the advantages to be derived from joining us. Under the provisions of the Local Government (England and Wales) Act, 1888, county surveyors will frequently be brought into business relations with the engineers of local authorities, and this Association affords them the means of becoming better acquainted with those gentlemen and exchanging views on subjects of mutual interest. The public authorities under which members of the Association hold office are constituted in various ways and under different Acts of Parliament, and the endeavour of the council has been to send out to members as representative a house-list as possible. I am much pleased to notice that the London, Scotch, and Irish members are represented on the new council; I hope that next year the county surveyors and the surveyors of rural districts will also be represented.

There has been a considerable change in the composition of the council this year, owing to vacancies created by those members who ceased to hold chief appointments under the Local Government Acts, and who therefore became disqualified by Rule 3, from holding office in the Association. No less than five members, including one vice-president, have been so disqualified since the previous election. This rule I think needs some revision.

The question of superannuation makes way but slowly. It was one of the main objects in view when the Association was originally founded, and has frequently been referred to in the addresses of your presidents, yet at the present time we appear to be a long way from a solution of the difficulty.

If some general scheme for superannuation on the lines laid down by several of the larger municipalities were sanctioned by Parliament, it would be a great advantage to the officials, and I believe a decided gain to the ratepayers. The corporation of Manchester are now seeking powers for the establishment of a scheme of thrift for their employees. What Manchester, Liverpool, and other large cities and towns have found to be right and necessary in the interests of both employer and employed is equally necessary throughout the country generally.

Even the so-called "Economist," if he will only look at the question fairly, will see that such a scheme would be the truest economy. There is no official connected with local government who requires such a complete knowledge of local matters as the municipal engineer, and until he becomes thoroughly conversant with every inch of his town or district, and with the works both above and below the surface, his professional services cannot be utilised to the fullest extent. Therefore it should be the endeavour of every local authority to retain the services of its engineer by giving him fair remuneration and a prospect of superannuation. If this were done there would not be such frequent change of officers as we see at present. Many would probably say, "Thrift is the remedy." Excellent advice, and those who practice it are to be highly commended; but it is quite beside the case we are considering, which is that of the underpaid public servant, who is obliged to keep up a respectable appearance, and from whom the most arduous and responsible duties are expected in return (in too many cases) for a mere pittance. I am not depicting an isolated instance, my remarks apply to a majority of local engineers; and to suggest to such men the virtues of thrift is nothing short of insult. No man worthy of the name will rest content if he feels that his

services are not fairly rewarded, and that he has nothing to look forward to when old age or sickness overtakes him. In such a case the official will naturally watch for every vacancy that occurs, and will use his best endeavours to procure a more remunerative position. Until that opportunity offers he will remain in a state of chronic discontent, which cannot be to the interests of his employers, who are themselves a changing body. I feel that I can speak freely upon this and other matters affecting the position of the local surveyor, as happily for years past I have had, and still have, the honour of serving a model board who value my services, and of whom both collectively and individually I cannot speak too highly.

Having said this, I will refer more particularly to the position of the local surveyor. The office is generally surrounded with peculiar difficulties quite apart from those attaching to his professional duties as an engineer. If he performs his duties in a conscientious and straightforward manner (which I believe most men endeavour to do) he must of necessity come into conflict with the wishes of many persons. These persons generally regard him with no kindly feeling, and oft times from purely personal motives seek election and obtain seats upon the Board he serves. The jerry-builder, the house-farmer, the small property owner, the private road frontager (especially the "flanker"), and many others, all have a supposed grievance against him. He must therefore be a man of more than ordinary nerve and tact if he can perform the numerous unpleasant duties which are cast upon him with a perfectly even hand. A public officer charged with such responsible duties should be placed beyond the reach of private pique and individual influence. Until this is done the important sanitary work necessary for the well being of the community cannot be satisfactorily performed.

The advantages of the voluntary examinations held by this Association are being generally recognised by the local authorities. We frequently see that pass certificates are required from candidates for public appointments; and many of those holding certificates of proficiency have recently been successful in obtaining appointments. These examinations are undoubtedly a step in the right direction. It will be admitted that there is no body of men so well qualified to test the ability of candidates for the office of municipal engineer as those who by years of hard work and experience have obtained a thorough grasp of the duties which a municipal engineer is called upon to perform. And in the same way as the Metropolitan Management Acts require all the district

surveyors in London to pass the examination of the Royal Institution of British Architects, so it ought to be compulsory that no man should, after a given date, be appointed as municipal engineer unless he has the certificate of this Association. Too much importance cannot be placed on the qualifications of those who are selected to fill such positions.

The knowledge required of a municipal engineer is considerable. He must be thoroughly conversant with all the details in connection with the work of the local authority; these duties have been so fully enumerated in the addresses of previous presidents, I will not here particularise them. He is now entrusted with work which a few years ago was generally placed in the hands of private practitioners. If the local man is competent he is generally in a better position (owing to his local knowledge) to design and carry out works in an economical manner. The knowledge to be derived from visits to works in progress, and hearing papers on engineering subjects read and discussed at meetings of this Association, cannot well be over estimated; such meetings lead to an interchange of ideas and the acquisition of knowledge of the greatest value to the municipal engineer, who, if he wishes to be abreast of the times must keep himself well informed of what his brother engineers are doing. The civil engineer must always be a student; the field of engineering is so vast, and the rapidity with which invention follows invention and improvement follows improvement is so great, that the more one studies the more one feels how little he knows. Conversing with an eminent electrician a short time since, I remarked "Your branch of the profession has been brought to a wonderful degree of perfection." He replied "We are only in our infancy yet. When I returned to England after a few months holiday, I found that I was quite antiquated in my ideas." The municipal engineer to be successful must combine both scientific and practical knowlege, and should also possess a considerable amount of tact. Young men who are desirous of becoming local engineers or surveyors and have passed the voluntary examination should not be content with the "pass certificate," but should immediately become graduates; they should be as constant as possible in their attendance at meetings, where they will have opportunities of inspecting works in progress, and of hearing papers read and discussed. If they are observant and make notes of what they see and hear, the knowledge gained thereby will be invaluable to them in future life.

The attention of most sanitarians will be centered in London this

year, where a meeting of the International Congress of Hygiene and Demography will be held from the 10th to the 17th of August next. Papers will be read and discussed on subjects relating to sewerage and sewage disposal, water supply, pollution of rivers, disposal of town refuse, street paving, subways, heating and ventilation, house drainage, and many other subjects of special interest to the sanitary engineer. Understanding from our secretary that there has never been a district meeting of our own Association in London, I would suggest that a district meeting be held in London in the second week in August, when many of our members will no doubt be in town for the Congress.

During the past year questions of water supply and sewerage have been occupying the attention of the London authorities. Whether the London water supply is to remain in the hands of the private companies or is to be transfered to the public, has yet to be determined by Parliament. What Liverpool, Glasgow, Manchester, Birmingham, Bradford, and most of the large towns have possessed for years, viz. the control of their own water supply, Greater London with its millions is still pleading for against the enormous private interests involved.

The able report to the London County Council upon the drainage of London, by one of our members, Mr. A. R. Binnie, M. Inst. C.E., in conjunction with Sir Benjamin Baker, M. Inst. C.E., is a valuable addition to the mass of printed matter already existing on this vexed question. It confirms the scheme of the Metropolitan drainage which was designed and carried out by the late Sir Joseph Bazalgette. The difficulties which attend so large an undertaking are many, and the cost is necessarily great; but the thousands of persons who suffer in consequence of the present congested state of some of the outfall sewers of the Metropolis will hail with satisfaction the adoption of relief works recommended in this report.

A subject nearly allied to that of drainage is the disposal of town refuse. Each year this is becoming a more formidable difficulty. With the increase of population there must necessarily be a proportionate increase of waste and worthless matter. I say "worthless" advisedly, although some persons suppose that use and even profit can be made of all waste matters. Theoretically perhaps, this may be so, but practice has proved the reverse to be the case. We live amongst artificial surroundings, and must adopt artificial means for the disposal of cast-off refuse. The rough and ready method hitherto adopted, namely, that of using it to fill up

low ground or disused quarries in the neighbourhood of towns can no longer be continued without endangering the health of the inhabitants. These means must cease to be employed. Science has shown us how that unruly element *fire* can be brought to our aid, and made rapidly and inoffensively to decompose this waste. That it is possible to do this without nuisance or inconvenience has been proved; and although the misapplied term "destruction by fire" has been termed "barbarous," the cremation of town refuse upon improved and scientific principles is undoubtedly the best known method of dealing with this difficult problem.

London is behind many of the large municipalities with regard to street locomotion. The tramlines are in the hands of private companies, and as the statutory period for which the concession was granted to the companies will shortly expire on some of the principal routes, their purchase by the County Council is now under consideration; this may perhaps account for the bad condition of several lines. With two or three exceptions the whole of the London trams are worked by horses. The use of steam has recently been prohibited on one surburban line, owing to the nuisance caused by the engines to persons residing near the route. One line has been worked by *cable* traction for some years, and another on this system is now in course of construction. Experiments have been made with electric motors, but as yet no Metropolitan tramway is regularly worked by electricity. Mechanical traction in the streets of London has always been regarded with much disfavour. If the City and South London Railway, which you will have an opportunity of seeing to-morrow, should prove a success, the system will no doubt be rapidly extended. The proposed Central London Railway, supplemented by a connecting link between King's Cross and Charing Cross, would do much to relieve the overcrowded streets along these routes. Londoners have recently enjoyed a week of quietude hitherto unknown, during the strike of the 'bus men, and have just had time to realise the benefits which would accrue if the lumbering omnibus were to give place to some better means of locomotion. If it be true that each person was saved ten working hours per annum by the invention of the friction match which replaced the tinder box, how much time would be saved by some better and quicker means of transit in London.

When the returns of the late census become public, useful deductions of great importance to the municipal surveyor can be drawn from the facts then made available. The information

already to hand shows that the population in some places has increased enormously; in the district which I represent, the population has more than doubled during the last decade. The increase of course depends on local circumstances, in some of the large towns it has not been so great as during the previous decade.

Questions relating to labour and hours of work have been constantly before the public of late, and may no doubt be taken generally as an indication of increased prosperity. They however frequently affect the estimates of those engaged in the construction of works, and have a deterrent effect on persons who would otherwise be disposed to tender at a small margin of profit. It appears to be simply a question of supply and demand, and although much inconvenience may arise before matters are finally adjusted, there can be little fear of the ultimate issue. In the meantime the municipal engineer, in pricing and estimating, must provide a fair margin for contingencies.

Notwithstanding the intimation made by the President of the Local Government Board that the Government propose to introduce a Bill consolidating and amending all the Acts relating to Public Health, we are still receiving Public Health Law by instalments, each Bill being so sifted and cut about before it leaves Committee that it is almost unrecognisable when it becomes Law. Since the Local Government (England and Wales) Act 1888 was passed we have the Public Health (Buildings in Streets) Act 1889, the Infectious Disease (Notifications) Act 1889, The Public Health (Rating) Act, 1890, the Infectious Disease (Prevention) Act 1890, the Public Health Acts Amendment Act 1890, and several other Acts of apparently lesser importance to the sanitary engineer. All bring extra work to the Members of this Association, and go to show how absolutely essential it is that each one should keep himself *au courant* with all that takes place. In view of the proposed legislation, the suggestions from Members of this Association (referred to in the Annual Report) ought to prove of the greatest value. Who better able to make useful and practical suggestions for an amending Act than those who have been engaged for years in carrying out the law under the existing Statutes?

In conclusion, let me repeat my fervent hope that the ensuing year may be one of increased prosperity to the Association. While I have the honour to be your President, no effort on my part shall be wanting to secure for it that position in the country to which it is justly entitled.

# WAY-LEAVES AND EASEMENTS.

By ROBERT GODFREY, A.M.I.C.E., Engineer and Surveyor to the King's Norton Rural Sanitary Authority.

One of the most difficult items which faces an engineer in the preparation of an estimate for carrying out any scheme of water supply or sewage disposal—when the sacred rights of private owners are invaded—is that item known as "Way-leave."

All other items in the estimate may be accurate and the result of experience, but when "Way-leave" has to be paid for, there is at once an element of chance introduced which no engineer can calculate, and it is in the hope that some information may be gathered on the practice adopted in different parts of the country that the writer of this paper ventures to lay before the members of this Association his own experience, and through the kindness of many members, to whom he now tenders his sincerest thanks, the experience gathered from various parts of the country.

No sooner does a local authority promulgate a scheme which involves the entry upon land, than at once the price of that land rises frequently a hundred per cent., and what was deemed agricultural land immediately becomes building land in the opinion of experts who are called in, or often invite themselves in, to advise the owner. The great railway speculations in the "Forties" which resulted in the Land Clauses Consolidation Act, 1845, with its subsequent Amendment Acts of 1860 and 1869, opened out a new field of practice for surveyors, and generated a new class of claims against speculative bodies, as all Railway Companies are; and the customs created in dealing with the purchase of land, and with easements which the speculators required, caused every owner to look upon such speculative companies as fair game for plunder.

The taste for compensation once imbibed, it is only natural that no opportunity should be lost for putting forward exorbitant demands on the chance of getting more than is expected, and of making a "good thing" out of any public body which in the interests of public health requires to invade the land of the private owner. Speculators could afford to pay high prices, and the range

of prices introduced by them still too often rules the minds of valuers when an easement is required by the public for the public good.

It is impossible to discover any principle upon which valuers for claimants base their calculations; the most absurd contentions are put forward, the sole object being, not to get what is fair and just, but to squeeze the authority as much as possible, and to get "costs," which to the comfort of the claimant are usually awarded to him.

Section 16 of the Public Health Act, 1875, gives to local authorities very large powers with regard to entry on lands for the purpose of making sewers.

Section 308 sets forth that any person who sustains damage shall be compensated; and Section 179 provides the machinery for settling that compensation; but Section 308 introduces a phrase which was not in the old Act, 11 and 12 Vict. c. 63, s. 144, and cases often go to arbitration to settle compensation before even the *fact of damage* has been settled. By Section 308 the arbitrators are required first to settle that damage has been done (and in many cases the local authority confers a positive benefit on private owners) before the question of amount should be approached.

A case in the writer's own district may be cited. It is a well-known fact that the outside of a pipe sewer or a water main is the means of removing a large amount of subsoil water. A sewer was laid through a boggy piece of land. Particular care was taken to make the sewer watertight, and the flow of sewage observed proves that the leakage water is almost nil. The result of laying this piece of sewer has been that the land which was before swampy and rushy is now very much drier and firmer than before, and produces better grass, yet the agents for the owners are at the present moment demanding 8*s.* per yard for way-leave, on the ground that the land is building land suitable for factories, ignoring the fact that the existence of the sewer provides them with the means of draining any buildings they may put on the land.

The favourite plea of the land agent is that the prospective value of the land is affected, and on this head it is well to remember that in the Appeal Court it has been held "that a person whose property was affected was only entitled to be compensated to the extent to which his previously uncontrolled use had been interfered with."

In assessing the damage done by carrying a sewer through land, the surface or tenant's damage is a matter of small moment, though in dealing with this, the fanciful estimates of land agents are amusing. A claim was made against the writer's Board for 28*l*. surface damage over 600 feet of sewer constructed in October; 6*l*. was offered and declined. A local umpire was agreed upon, who awarded 13*l*. and costs, the latter amounting to 20*l*.

In considering the *fact of damage* as against the owner, there are a number of points arising which require careful consideration:—

1. The local authority acquires an absolute right to the subsoil occupied by the sewer; this was settled by the case Taylor *v*. Corporation of Oldham (4 Ch. D. Reports, p. 395), and reading that judgment by the side of Section 16, Public Health Act, 1875, a private owner loses his freehold—as the right to enter is absolute, and the legislature, while giving such arbitrary powers in the interest of public health, would not inflict an injustice on the owner by depriving him of his freehold without payment.

2. The local authority acquires a right of support, but in non-mining districts this is not a point of importance. The Act of 1883 (46 and 47 Vict. c. 37) is designed to meet the difficulties which arise in mining or brine-pumping districts. This right includes lateral as well as vertical support, and difficulties might arise in working brick earth, &c.

3. The course of the sewer may interfere with a building plot, but frequently this can be arranged so as to suit the *convenience* of the projected laying out of the land. For dwelling-houses there is a strong objection to being built over a sewer, but for factories this objection does not arise to such a degree, and the local authority may exercise the permissive power of Section 26, Public Health Act, 1875.

4. The right of way which the authority acquires over the line of sewer is a natural sequence to the acquirement of the subsoil, and it is here that very great divergence of opinion exists. Theoretically this right of way for the authority, their servants, with horses and carts, to enter upon the land is acquired, but how often is it necessary to repair a sewer laid through private lands?

5. The most important point is the fact that the owner loses his hitherto uncontrolled use of the land, and though his surface enjoyment of the land may not be diminished, still his absolute freehold is encroached upon, and for this no doubt compensation is

due, and it is in arriving at this amount that the members of this Association have the greatest interest in discovering some fixed principle on which to assess it.

Manholes and ventilators are a very fruitful source of expense in the awards of umpires. How the sum of 20*l.* per manhole and 5*l.* per ventilator was arrived at puzzles most people, but these are the figures frequently claimed, and, unfortunately, frequently awarded.

On looking through a number of reported cases, curious claims are seen. In Heal *v.* Finchley, one witness claimed 1*s.* 6*d.* per foot for 3534 feet of sewer, and 30*l.* for each manhole. In Peake *v.* Finchley Local Board, 20*l.* was claimed for manholes and 10*l.* for ventilators.

Before finally deciding upon the line of a sewer, the owner of land which by any stretch of imagination can be called building land, would, as a matter of courtesy, be consulted, both for the purpose of ascertaining his views as to compensation, and also as to his ideas as to laying out his land for building. Mutual concession often avoids expense, but when all has been done to meet the owner, and still he claims a large amount of compensation, then the need of a general principle comes in, and it is to be hoped that the members of this Association may be able to formulate some such principle, and to adhere to it in all cases in which they have to negotiate for sewer easements.

The claim for prospective damages is one which requires very careful watching. The claimant will put it forward whenever he can, and counsel will urge it, but it must be resisted whenever it arises, as let a decision be once given in favour of such a problematical quantity, there will be an end to all works through private land, and the influence on the rates will be appalling. Too often the public purse is looked upon as legitimate prey, and it behoves the members of this Association, as the custodians of the nation's health, to resist all and every attempt to render works designed for the public weal to be hampered by fanciful claims for compensation and damages.

The influence of the railway era, with its gigantic monopolies conferred upon speculators, is felt in all arbitration cases. Parliament conferred on railway and other companies special powers (the transfer of land from one to the other being a purely personal matter, carried out in the hope of profit), and the Arbitration Clauses were embodied in the Public Health Act as affording a means of

facilitating the acquirement of land, but for public purposes as distinct from private gain. Consequently the fanciful prices which had been obtained in the case of the companies lingered in the memory of men engaged in the settlement of those disputes, and when they came to have to deal with a sewer or water easement they naturally sought to obtain *pro rata* compensation.

In the Fulwood case the owner claimed 1200*l.* for consequential damages, asserting that his water supply was damaged, and that reservoir and turbine would be needed, the way-leave being charged 7*s.* per yard additional. The award in this case was for 480*l.*, equal to 2*l.* 14*s.* per yard, and, without knowing the terms of the award, it would appear that something was allowed for consequential damages.

By the Land Clauses Act the question of costs is left entirely with the umpire, and the almost universal rule seems to be that the authority shall pay. Here a great injustice is often done. A fancy claim is set up, the authority has to engage expert evidence to meet it, and then the award saddles the costs of both sides on the authority, which, in its duty to the public, has resisted what is often a preposterous claim.

In one case in which the writer was concerned, the claimant sought to obtain 300*l.*; the umpire gave him 15*l.*, and each party to pay their own costs; but such awards are exceedingly rare.

The provision in the Act, by which the umpire has power to mulct the claimant in costs in the event of his award giving him a sum equal to or less than that tendered by the authority, requires amendment. It should be within the umpire's power to discriminate between evidence which is necessary and what is unnecessary, and deal with costs accordingly.

As an illustration of the exorbitant sums paid for costs, the following figures have been supplied me by a member of the Association:—

| Length of Sewer. | Payment for Easement. | | | Costs. | | |
|---|---|---|---|---|---|---|
| yards. | £ | s. | d. | £ | s. | d. |
| 538 | 281 | 18 | 0 | 122 | 15 | 2 |
| 416 | 375 | 0 | 0 | 123 | 3 | 0 |
| 305 | 175 | 0 | 0 | 72 | 8 | 0 |
| 60 | 30 | 0 | 0 | 23 | 12 | 8 |

And doubtless many others could be furnished.

On the question of *Easement*, some better defined principle is required; but to look for it in the awards of umpires is lost labour.

In the case of Crisp *v.* Finchley Local Board, the counsel for the claimant distinctly ignored the *easement*, and claimed *damages* only, while in Peake *v.* Finchley, an eminent Q.C. said it was the universal rule to allow for easement.

By Section 16 the right of easement seems granted; and Section 308 seems to limit payment to damage. That the easement itself is not a ground for damages was held by the Metropolitan Board of Works, and they resolutely declined to pay anything on that head.

In the case of Rawkins *v.* Ilford Local Board, the right of the owner of the freehold of a road was set up successfully, and to a great extent dangerously.

A footpath is by the Highway Acts a public road, and as such the authority of a district has a right to lay a sewer along and under it. In this case the Local Board laid a sewer in certain land at Ilford, over which the public have a right of way, the sewer being constructed under the footway—as a highway. Forthwith a claim was set up for the value of the brick earth removed from under the footpath, and the amount claimed was put down by two witnesses as 751*l.* and 647*l.* respectively. The Local Board valued the damage at 75*l.*, but the umpire awarded 210*l.* This is a case which should be borne in mind, as it may be quoted by the owner of any land adjoining a public road, and a claim set up for every load of gravel, sand, clay, &c., removed from the trenches during the construction of a sewer, and carted to the spoil bank.

At Hackney, again, a claim was made for 1516*l.* for taking a sewer under a footway, and the award gave the claimant 515*l.*

In endeavouring to arrive at a principle on which to assess the damage done, if any, by reason of taking a sewer through private land, the examination of a great many cases reveals the fact that the witnesses have very hazy notions as to the lines on which they assess the damage for which they claim compensation.

The practice seems to be obtaining now of allowing half the value of the freehold of the land taken, and various widths, varying from 6 feet to 66 feet, are set down as being the ground occupied by the sewer. In a case at Hornsey one of the claimant's witnesses takes the width at 1 chain—a preposterous contention; while, in a Finchley case, one of the witnesses for the Local Board put the width at 6 feet.

In the Compton Gifford case the claim was calculated on a sum of 3*d*. per square foot.

By the Housing of the Working Classes Act, 1890, a distinct advance is made in the matter of arbitration. By Section 41 (1) "The amount of compensation shall be settled by an arbitrator, to be appointed and removable by the Local Government Board"; and it would be a good thing for Local Authorities if, in the forthcoming Revised Public Health Act, a similar clause is inserted. The era of fancy prices would then come to an end, and a commonsense basis would obtain.

On what principle could an umpire award 12*s*. 6*d*. a yard and costs against an authority in one field, and then on the other side of the hedge accept 7*s*. 6*d*. and a small sum for costs? Yet this was done in a case within the writer's experience.

There will be no certainty of obtaining a fair award where the parties go to arbitration, until the authorities avail themselves more largely of the sub-section of Section 180, and leave the Local Government Board to appoint the umpire; and the writer would strongly urge all the members of this Association to adopt that course, and so take the matter out of the hands of a few men, whose awards are as curious as in many cases they are unjust.

An exceedingly valuable precedent has been established at Birmingham, where a sum was paid for a way-leave for a sewer, but an agreement was entered into between the Corporation and the owner, in which it was arranged that if ever the owner laid a street alongside the sewer, the money paid for way-leave was to be refunded. This is the only instance I have been able to find where such an arrangement has been carried out.

In conclusion, the writer cannot but thus publicly express his gratitude to all those members who have supplied him with the information tabulated at the end of this paper, and he hopes that the record of the cases embodied in the Table may be of service to others, as it has been to him.

| 8. ...nount paid. | 8. ... per manhole. | 9. If by arbitration, was the umpire agreed upon, or was he appointed by the Local Government Board under Sec. 180, 7 Pub. H. Act, 1875? |
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| ion only p ... the event ... the sewers ... towards th | | |
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| 8. ttled by arbitration. | 9. If by arbitration, was the umpire agreed upon, or was he appointed by the Local Government Board under Sec. 180, 7 Pub. H. Act, 1875? |
| --- | --- |
| mostly by arrange- | Yes; one arbitrator appointed for all cases, umpire agreed upon when required. |
| .. .. .. .. | Agreed upon. |
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| it. | |
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| l as to the valuation, which I think was about 7*l*. 10*s*. | |
| n .. .. .. .. | Umpire agree upon. |
| gement; the whole y-leave is through ging to the Trus- Earl of Dysart. | In several other instances of sewers through private properties the Corporation has paid a lump sum down, always by arrangement, but the Trustees of the Earl of Dysart will not accept a lump sum payment. |

| 3. | 6. | 9. |
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| mount paid. | paid per manho | If by arbitration, was the umpire agreed upon, or was he appointed by the Local Government Board under Sec. 180, 7 Pub. H. Act, 1875? |
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| but mostl / case of th / 16·30 sh / age to crop | rough College / .. .. .. | e outfall sewer. I have not the / Umpire agreed upon. |
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| ors acting for other side. | No reference to arbitration. |
| .se, through a manu- 130 yds., with one and one manhole, 0*l*., special damage | Arbitrator agreed upon. |
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| ases; in others by rrangement. | Agreed upon. |

## DISCUSSION.

Mr. Eayrs: I rise to move a vote of thanks to Mr. Godfrey for the paper which he has given to us. It is one of exceeding great interest to the members of this Association, as no doubt most of us have had to meet cases of way-leave and easement very frequently. The subject of the paper has occupied my attention for some time, and I had thought of preparing a paper on this very subject for the Association, but as Mr. Godfrey has dealt with it, I feel sure very little can be added to the particulars he has given. The tabulated returns at the end of this paper are very instructive, and go to show that many Boards have not dealt with the cases on any system but by rule of thumb. As a general rule, if a man wants compensation for easements he asks some fabulous sum, you go to the other extreme, and offer an absurdly low amount, and you eventually come to an agreement between the two. Nowadays we are coming to a system upon which to calculate these easements, and it should lead to a general rule for the assessment of damage, and relieve us of these costly arbitrations to which we are often subject. We often find very great difficulty in getting particulars of claims from owners. They send in a claim for a certain amount, and when asked for particulars they say, "We have no particulars to give you, but will go to arbitration." You say, "There cannot be a dispute until you have the particulars, of a claim, and until you get these you decline to pay." You do not decline to pay, you do not dispute damage being done. If you stand out and refuse to go on until they give these particulars they are in a fix. It is very uncertain whether the Court would compel you to go to arbitration until they give particulars of their claim. We have a case in which the owner claimed 465*l.*, where we offered 85*l.* They have now increased their claim to 1100*l.* We have asked for particulars of the claim to be made out. They do not know how to give them, and do not know how to go on. We are in the happy position of having the money, and we do not intend to proceed until they give us the particulars of their claim. The system I follow is to take the length of the sewer and multiply that by eight yards, multiply that by half the value of the fee simple, adding for ventilators, storm overflows, and various other matters. To ascertain the value of the land, we get

at the rent paid, rateable value, and also the prices at which land is sold in the neighbourhood. Of course, this varies considerably, and is a fruitful source of getting specialists and surveyors—one to say it is worth 5000*l.* an acre, and another 50*l.* an acre. Some surveyors take the length of a sewer, multiply by a width of three to four yards, multiply by value per acre to arrive at the annual value, and multiply that by 40 or 50 years' purchase, then dividing equally between owner and local authority, adding fixed sums for manholes, ventilators, &c. I will give you a few instances of amounts we have paid: on a 3 feet sewer, 1*s.* 7*d.* per lineal yard; 3 feet 3 inch, 1*s.* 11*d.*; 2 feet 6 inch, 1*s.* 8*d.*; 2 feet 9 inch, 2*s.*; on a 2 feet 3 inch sewer, 2*s.* 4*d.* and 4*s.* per yard; and I have paid 5*s.* on one occasion. These seem reasonable amounts, and if you can get off with these you can consider yourself fairly dealt with. We have had a number of cases, and with only two exceptions I have not had to refer to arbitration at all. I hope other members may be in the same position. Unfortunately, owners are beginning to think they have not been paid properly before, and are beginning to try to bleed us. In many cases the sewer is an improvement to the land, and I am sorry the "betterment" principle does not apply. What an owner would otherwise have to pay for out of his own pocket he gets done by the local authority, and he also expects something for compensation. I think the boot ought to be on the other leg, and he ought to give something towards the cost of sewer as well as free easement where he is benefitted. We have a claim pending where 30*s.* a yard is claimed, and we are offering 1*s.* 10*d.* I have one case where we carried a sewer through land which contained some few ironstone nodules of no practical value, and they wanted to claim for the value of the ironstone we took out of the trench. What material we took from the area of the sewer was claimed for in compensation. I need hardly tell you they did not get anything. Another instance was where a man had a piece of land away from the town, where he had his clothes washed. He was a large grocer in the neighbourhood, and there was a good deal of washing to be done. We carried a sewer through his field, and he claimed damages because he said he was unable to hang his clothes out after being washed owing to the sewer trench being partly across the field. That is an illustration reducing it to a very absurd principle.

Mr. Smythe: As the surveyor to the Finchley Local Board referred to in Mr. Godfrey's admirable paper, I should like to give

a peculiar instance which occurred in regard to way-leave. The main sewer was laid through glebe land, and *my predecessor arranged with the surveyors to lay the sewer in such a way that at any future time the surveyor would be able to develop the estate.* As a matter of fact it was through a rough piece of land known locally as "the rough lots," a low waste common, and after the sewer was laid compensation was claimed to the tune of something like 886*l.* for about 400 yards. Of course the Board refused the amount, and it was referred to arbitration. Arbitrators were elected on each side, and finally an umpire. We offered 300*l.* as against 886*l.* claimed. I remember attending the arbitration, and *their surveyor brought out a perfectly different plan to that previously arranged,* in order to assist his computation that the sewer would pass through a large number of houses. That is a case in point in reference to way-leave. My experience in reference to way-leaves is this: the claimants put down fictitious sums; you on the part of the Local Board put as near the proper sum as you can; an umpire is appointed and he splits the difference. In all these cases there are members of the Institute of Surveyors and other professional gentlemen on the one side to refute any statements made by the professional witnesses called in on the other side, and the result is an enormous amount of costs is piled up. My experience is that it is more costly to go to arbitration than to pay the money down. The fairer way in all such schemes where you have way-leaves to contend with (and I should prefer it, as a purely uninterested verdict would be given), would be to refer it to the Local Government Board to hold an inquiry similar to those held for the loan for the sewage scheme itself. Claimants for way-leave might be represented before that arbitrator, and the result would be a verdict, I think, given fairly to both sides. That is my opinion on this question of way-leaves. Mr. Godfrey mentions the case of Heal *v.* the Finchley Local Board. I know a very fair sum was offered to Mr. Heal in the first instance, amounting to something like 18*s.* a yard, and I know if it had not been that he was a lawyer, and wanted to get every penny he could out of the Board, it might have been arranged amicably. My experience is that arbitration cases are worse than if you paid the first sum asked for.

Mr. Eayrs: My Corporation now practically refuse to agree to any local umpire, but leave it to the Local Government Board to appoint an independent man.

Mr. W. H. SAVAGE: I do not think any amount of discussion will help us very much on this question, as it is so dreadfully complicated, but Mr. Godfrey's suggestion to refer these matters to the Local Government Board appears to be the proper one. If they would only take some responsibility and make a stand, it would strengthen our hands. To show the absurdity of many of these claims: We have recently had a tenant's claim for 326*l.* for damage to land and crops by the construction of a sewer. The sewer trench occupies about one-fifteenth of an acre. It is true we are disturbing about an acre and a quarter, but the claim is out of all proportion to the damage, and how the figures are arrived at puzzles me.

Mr. J. MANN: It affords me pleasure to support the resolution of thanks proposed to Mr. Godfrey. I had written to him in reply to his inquiries, stating I would endeavour to give him particulars as to compensations paid in my district, but I was not able to get the information in time to be included in his paper. We have had some very peculiar experiences indeed. Some compensations were paid at the rate of 6*s.* 8*d.* per foot and 10*l.* per manhole, others at a less rate, while in another case, with land not so valuable, 1*l.* per foot and 10*l.* per manhole was paid. The solicitor's and valuer's costs were over 400*l.* In many instances the value of the land appears to have little to do with settling the amount of compensation payable, the owners of the most valuable land often receiving less than those of other land of smaller value. In one case 1250*l.* was paid for a way-leave of 1200 feet, and the costs were 450*l.*; while in another case, for 1400 feet through more valuable land only 550*l.* was paid, with correspondingly reduced costs; but in the former case the solicitors acting for the owner fought the case more keenly, supported by valuers of high standing, with the result given.

Mr. ELLICE-CLARK: Mr. Godfrey's paper is at once a vigorous onslaught upon property owners and arbitrators. Would it not be difficult to lay down any general principles to settle disputes arising on the compulsory acquisition of land? Doubtless there are details to which general principles might apply, but any attempt to lay down general laws as to the amount of compensation to be paid for the right of laying a sewer through a particular property must end in failure. It may be mentioned, in West Brighton a sewer was laid through a farm the rent of which was 2*l.* 10*s.* an acre. In ten years' time that land was sold at 10,000*l.*

an acre. No one had an idea that in so short a space of time the land would have anything more than an agricultural value. One understands the motives of a beaurocrat who says, "It is the duty of every local authority to resist every claim that may be made upon it, from whatever source it may come," but it is equally clear to be the duty of every property owner to resist every encroachment on his rights, from whatever source it may proceed, parochial or otherwise. Mr. Eayrs quoted one such owner, who claimed for the minerals excavated; but one would like to know to whom the minerals belonged if not to the owner of the land. Do not forget that the local authority comes with the fullest powers ever granted by the Legislature, viz. the compulsory acquisition of the fee simple. Assume that instead of iron, gold had been found. Does he say the local authority would have had the right to take that precious metal without paying for it? It is said the iron was thrown back into the trench, but as they acquired the soil, whatever they did with it, the owner would still have lost what might have been to him a source of considerable wealth. The suggestion of Mr. Eayrs to lay down general principles for regulating some of the details is an excellent one. It will be of value in focussing the minds of surveyors and valuers upon one point, but if you are going to try and lay down general principles as to the value of property, you will start one of the most difficult problems you have ever had to face. Mr. Godfrey speaks of the influence of the railway era, with its "gigantic monopolies" conferred upon speculators as being felt in all arbitration cases. One would like to know what this country would be without that gigantic monopoly, the railway system. What state would the coal, iron, and every other industry be in, if an enormous sum had not been spent on railways? and, after all, with a part of such expenditure unproductive. If you look at the Board of Trade returns you will find that the interest on capital invested in railways is very moderate. One must admit that they are monopolies, but from experience in other countries one must say they are on the whole, well-regulated monopolies. As to the particular cases cited of extravagant claims, and the small amount of compensation which has been ultimately awarded, does not this occur in all contentions? We have a State judiciary trying these very disputes. The law of England is largely made to settle the disputes of individuals. The claim of the property owner is sure to differ from the valuation of the Local Authority. If the arbitrators give absurd decisions and grant compensation which

appears unreasonable, they only do what the judges of this country have done over and over again. It is the fault of an individual, not of a system. Another point raised is that when an award is made the costs are saddled upon the Local authority. One would like to know on which party they ought to be saddled. Take the greatest legal case of this century—the Tichborne case. The costs of that case were saddled upon the nation. It would have been the grossest injustice for that estate to have borne costs to the extent of a quarter of a million sterling in defending it against the claimant. Where a Corporation acquires private property, and the owner disputes, not their right to acquire, but the amount they are to pay, the costs should fall upon the local authority. That appears to me on general grounds a very fair principle. Take an instance. A man is a small property owner; the Local authority, say, of a great city like Liverpool, wants his house. There is a difference between the value he puts upon his house and what they will give him. The value of that house might be swallowed up in costs. The city of Liverpool might put the best expert witnesses into the box, as they have a standing machinery of the highest kind for fighting. But the individual has nothing of the sort. He has to go from his work to defend his claim, and it would be unfair to say that he shall pay the costs. There are, of course, ridiculous verdicts given—that there will always be, until the end of time.

Mr. C. Jones: It is very evident there are two sides to this question. I am very much inclined to agree with Mr. Ellice-Clark. Our friend Mr. Godfrey is looking for the millenium, and Mr. Clark does not want it. If the millenium came from his point of view I do not know where some of us engineers would be. The time has not come, I fear, when we can dispense with these legal matters, and the costs arising out of them. I think where the costs seem to intrude themselves most offensively is the *small* class of compensation cases. If some mode by which they could be dealt with were adopted, it would be a great advantage to all parties. Take the case to which Mr. Savage has referred. A man asking the entire gross value of the land, and if you won their arbitration the costs would amount to as much again. The costs of the small arbitrations, where you have to take a small piece of land, where experts are engaged on both sides, and the costs amount to three times as much as the land itself, is where we feel arbitrations to be oppressive. There are cases as ridiculous in another

way. I remember many years ago running a sewer through a gentleman's park. He did not know anything about it; and he engaged an eminent London surveyor, who knew less. This surveyor said to me, "I find you have power to go through the park, and of course when we want to come into the sewers we can do so without paying." I said, "Yes." We laid the sewer through that park without its costing us one penny for easement. The land was sold twenty-three years after, and this very sewer, for which no easement had been paid, proved a very serious impediment in the laying out of the property. The surveyor knew nothing about the question, and we profited by his ignorance. I think the discussion of this question will open it up in some way, and show whether some means cannot be devised by which this matter can be brought before Parliament, and something done to simplify arbitration in connection with small cases. I do not know whether it is a matter which could be referred to the Parliamentary Committee—if so, it would be well to have it considered.

Mr. J. S. Brodie: The sole difficulty of arbitration we have to deal with in Local Board work arises from the fact that the Land Clauses Act, which provided machinery for the purchase of land for railway work, is applied for a different object. The Land Clauses Act was passed to protect owners of property from people seeking to take land simply to make profits, and they were very properly saddled with considerable expense; but that always seems to me a different case from the carrying of a sewer through urban land, where the owner shares largely in the benefits arising therefrom. The proposition in the paper as to an arbitrator is a sound principle; but I for one should not like to have anything unfair in regard to private owners. Probably this question of arbitration by the Local Government Board will eventually provide some adequate Court of Appeal to prevent any injustice being done. I began to think we should not have an interesting discussion on this paper unless we had a private owner here, but one of the speakers has taken that side, and brought forth a profitable discussion. In my own district of Whitehaven no charge whatever has been made by owners for sewers which have been laid upon private land. The large owner there—the Earl of Lonsdale—has taken a very generous view of it, and that seems a right and proper thing, as a sewer is generally a great benefit to the land.

Mr. J. Barber: Under the Metropolis Local Management Acts I have carried out many miles of sewers, with manholes, &c.,

including a considerable portion through private property, and have never had to pay for way-leaves, or any other compensation than for damage to crops, the property itself having been improved by the presence of a good covered sewer. With regard to compensation for other public improvements, I may say that my Board have recently acquired some strips of park land, forecourts, &c., for widening a public road, under the powers conferred by "Michael Angelo Taylor's Act," 57 Geo. III., c. 29. I have found an enormous difference between the claims made and the claims settled. In one instance, a claim of 3315*l.* for a strip of park land was settled for 800*l.* Being desirous of completing an improvement begun in another public road, we wished to take down a projecting wall about 5 feet long, and perhaps 8 feet high, used for advertisements principally. In this case the claims for compensation from the freeholder and the leaseholder amounted to 340*l.*, and these are to be settled for 45*l.*, and some 12 guineas for costs.

Mr. Ellice-Clark: It would be interesting to know where private owners can be found to give up their land for public sewers without payment.

Mr. W. H. White: I should like just to mention one small case which goes to illustrate the point made by Mr. Jones, as to the hardship he considers is entailed in very small cases of compensation. This was an instance of a small piece of land being required to widen a street—a piece not much larger than this table. The owner claimed 100*l.*, some negotiations took place, and he reduced his demand to 50*l.* The Corporation offered him 25*l.* The case went to arbitration, valuers were engaged on both sides, and an umpire was appointed—a local umpire, not living in the town but near it. His award practically split the difference, as he allowed about 38*l.*, but when the costs came to be added, the amount payable by the Corporation was 68*l.* or 70*l.* I have given the figures from memory, but they are approximately correct.

Mr. J. Lobley: The amount of accessible literature on this subject is very meagre indeed. We are not flooded with the number of law cases that we have upon the 150th section of the Public Health Act, and the arbitration cases which nearly always settle these matters are not accessible to the general body of surveyors. This is to be regretted, as they would be very useful in showing us the principle on which arbitrators act. I have been very fortunate in not having paid any compensation for way-leave for sewers. Owners of land have tried to get an annual payment, but I have

resisted these claims, saying, "There was no claim under the Act for the payment of an annual way-leave. It must be a lump sum down, and you must prove the damage done." I have succeeded in convincing them that they could not otherwise get anything. I have one case where a sewer had to be laid across a field diagonally, and compensation was inevitable. In this instance I succeeded in inducing my Council to make a new and useful public road at probably little more cost than would have been paid for way-leave for the sewer. In other instances useful street improvements, that would not in all probability have otherwise been carried out, have been made in consequence of the necessity of making sewers on private land, and at the same slight additional cost. In another case I have been waiting a number of years for the owner of a field to lay it out for building purposes, but that has not been done, and the sewer must be made soon, when no doubt compensation will be claimed. I have a case where the sewage runs into an open water-course. The owner of the land does not produce any sewage, but the property adjoining does, and it is practically an open sewer. When we come to substitute a sewer for this open water-course I do not know whether any compensation is due. It has been a sewer for forty years, and it becomes simply a question of making it a covered sewer. The other point, with regard to adopting a varying width of 3 yards upwards would be a very good rule, provided it varied in accordance with the size and importance of the sewer; and I do not think it should apply where a property, as mentioned by Mr. Eayrs, would be ultimately benfitted. If a sewer were laid along the line of a new street, and would save the owner the cost of making a sewer, the compensation, if any, ought to be merely nominal. Some better mode should be found of assessing the amounts due than by costly arbitration. We all agree in theory with the views of Mr. Ellice-Clark as to the rights of owners; but I do not think they stand in great need of a champion, for they have so far proved themselves capable of protecting their own rights. I desire to thank Mr. Godfrey for a paper which is particularly interesting and useful, and on a subject with little available information at hand.

Mr. J. Lemon: Some of the speakers have particularly referred to costs. I do not complain of costs: some of us live by costs. But I do complain of the way in which costs are paid. I think if you appoint an umpire you should appoint an umpire who has the courage of his convictions. Where the owner makes an extravagant

claim, or where the authority offer an absurdly small amount, the costs should go with the event. I think in the case of Oxford the Corporation of Oxford richly deserved all they got. When they had such a small matter as 25*l.* they ought to have settled it without going to arbitration. It is very difficult to lay down any fixed line as to what shall be paid for compensation. But we should not forget this fact, that in the case of Taylor *v.* the Corporation of Oldham it was decided that the authority obtain an absolute right to the subsoil. I am always willing to pay the absolute value of the freehold. It is entirely a question of the land required, whether 3 feet or 6 feet, and on that basis I am always willing to pay compensation. In the matter of compensation sometimes disputes arise from want of forethought on the part of the engineer or surveyor in laying out his scheme. If the surveyor would put himself in communication with the owners of the property he would very often lay the sewers so as to meet the views of the owners, and so decrease the cost. I have had a case in my experience recently. I put myself in communication with the owners, I have diverted the sewer, and I shall have to pay less in compensation. I utterly disagree with the laying of a sewer in a diagonal line across a field which will become building land, when you can, with a little care, lay it at a right angle so as to cause little damage. I believe in what Mr. Ellice-Clark has said, that local authorities have very great powers, and I think they ought to exercise them with care and judgment.

Mr. A. M. Fowler: If a man makes a claim, and if the other side do not pay sufficient into Court to settle the matter, they are mulcted in costs. So an owner runs a great risk if he sets his claim too high. "As to trying it on," I do not think it is wise in our own circumstances to discuss it from that point of view. That is putting the case too strong. Supposing you put a sewer 10 feet or 15 feet deep through a man's land, that land will settle for five or ten years, and he cannot build over it. I have had alternative lines which cost 1000*l.* to take it off one man's land and put it on another's. Therefore it is important that you should try and meet the owner. He looks at it through different spectacles from what the local authority does. Parliament will not alter the law on this question, and we should look rather ridiculous if we were to ask for such an alteration.

Mr. Weaver: I do not know whether the metropolitan phase

of the question has been touched. The Metropolitan Management Act, 18 and 19 Vic., c. 120, s. 69, gives the local authorities powers to take sewers wherever they please, only paying for damage done, and not for the value of the land. That is the law affecting the metropolis. You do not have to take the land traversed by the sewer, but merely have to pay for the actual damage caused.

Mr. J. Hall: I should like to ask whether it has ever been attempted to purchase the freehold of the land instead of paying for the way-leave. There are many cases in which this would be the cheaper course.

Mr. Gledhill: It has struck me that the main part of the question has not been touched, according to my view of it. I believe that a great many of these arbitration cases and way-leave cases might be avoided if the lawyers were kept out of the question. At least, that is my experience in several cases I have had to deal with—even in obtaining a Provisional Order. My Board recently obtained a Provisional Order without engaging a lawyer at all. The clerk, who is not a lawyer, and myself, came up to London, deposited the plans at the Local Government Board offices, put a lawyer's name, with his consent, at the bottom of it, and the Provisional Order was obtained without the lawyer ever putting a finger to it. We have obtained land for the widening of streets, and way-leaves for sewers; and in some cases where the Board have failed I have succeeded in effecting an agreement. I have gone to the owner and pointed out the benefit of the work, and have generally induced him to agree to it. We have had to fight one case in which an award was made, but nothing was said about the coal. Our barrister's advice was to have the bill taxed. The bill was for 1400*l.*, and 1100*l.* was taxed off it, because the parties had tried to make the Local Board pay for the coal which they had previously sold.

The President, in closing the discussion, said: I have got some cases at present under consideration, so I do not like to express an opinion one way or the other, but I agree with some things which have been said on both sides. With regard to arbitration, I think sometimes fictitious matters are introduced into claims. In such cases it is always good policy for the local authority to pay, or to offer to pay, a fair sum to avoid arbitration. We all know that costs must be incurred in arbitration. When a

large sum is in question you cannot do without arbitration; but small amounts should, if possible, be settled by agreement. The expenses given in the tabulated statement are, I think, very moderate indeed. In fact, I should not have cared to have acted as arbitrator in some of these cases for the remuneration paid. I quite agree with the various speakers that it is a very excellent paper. It is the first time the subject has been before this Association, and I am very glad it has brought out such a very interesting discussion. I will ask you to accord a hearty vote of thanks to Mr. Godfrey for his admirable paper.

Mr. GODFREY: I must thank you most cordially for the vote of thanks, and I must also ask a great number of members to accept thanks from me, as I am indebted for very much of this information to members of the Association. Mr. Ellice-Clark rather takes a higher flight than I propose. I do not want to lay down any principle as to the sum we shall pay, I only say we ought to fix some principle upon which to consider the claim. We do not want to pay for 66 feet across a sewer when a sewer is only a 12-inch pipe. With regard to the prospective value of land, I still hold, in spite of Mr. Ellice-Clark's argument, that I am right, and he goes very far to prove it. Mr. Ellice-Clark gives us an instance of land at Brighton which was let for 2*l*. 10*s*. per acre, and in ten years' time was sold for 10,000*l*. an acre. How much of this increased value was due to the sewer which had been laid across the land? If the way-leave of that sewer had been laid upon the prospective value ten years hence, would it have been possible for the authorities to have laid it at all?

Mr. ELLICE-CLARK: I may mention that a considerable portion of this sewer had to be taken up when the land came to be used for building purposes.

Mr. GODFREY: With regard to valuers "*trying it on*," I speak feelingly on that point, because I have had several cases of local land agents who have sent in claims "*trying it on*," and who have not proceeded further with them when we have shown fight. It is against that class of pretender I ask for protection. I say to members, agree as to your arbitrator, but disagree as to your umpire, and let the Local Government Board send down a man.

Mr. FOWLER: Both sides agree to the Local Government Board nominating a man.

Mr. GODFREY: Whenever I have cases I always say, "I shall

not agree to an umpire you nominate, as I am sure you will not agree to one I nominate. Let us therefore ask the Local Government Board to appoint an independent man." That is provided for in the "Public Health Act, 1875, section 180 (7), and it has proved beneficial in my own case. With regard to the table, I shall be very pleased to supplement it with any further information, and to make it as complete as possible.

# HOUSE DRAINAGE.

By THOMAS WALKER, M. Inst. C.E.,
Borough Surveyor, Croydon.

In the author's district the local authority has decided that where the drainage of two houses unites, the length forward to the main sewer is also a sewer, and as such is to be kept in order by the local authority.

It is not intended to provoke a discussion on this point, but upon the best way of carrying out house drainage, where the above principle is admitted and the Model Bye-laws are adopted.

In the drainage of detached and semi-detached houses there is no difficulty in having a separate drain for each house; but where houses are built in terraces, unless the drain for each house is allowed to be laid under it, combined drainage must be allowed.

In Croydon all drains upon highways and the junctions in private roads are laid by the Corporation workmen, after the charges for the same have been paid by the applicants.

The sketch shows the plan recommended by the author. Drains which will become sewers are represented by the dotted lines, and, with the inspection chamber, would usually also be laid by the Corporation men, after the charges have been paid. It shows that eight houses may be drained into one sewer laid down an open passage, four houses being on each side of it.

The advantages claimed for the plan are:—

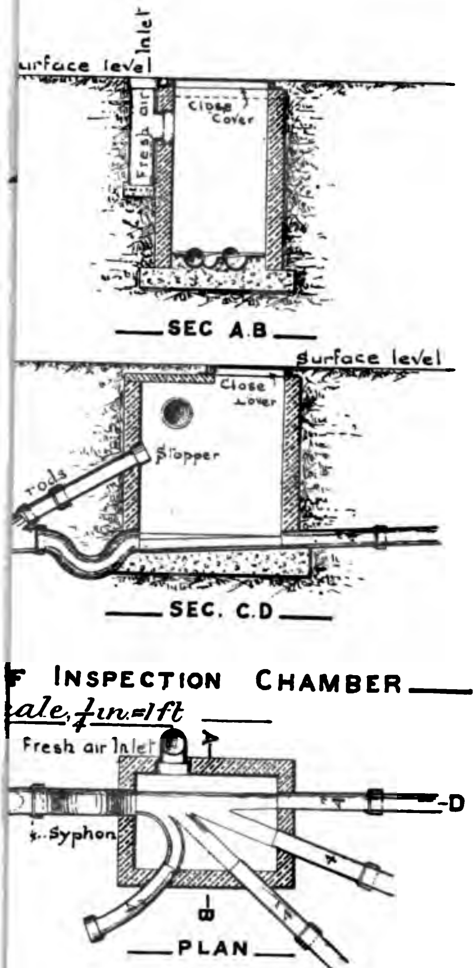
That it allows of rows of houses, without drains passing under each house.

That the length maintained by the local authority is distinct from the drains for which the individual owners or occupiers are responsible.

That the air-tight cover on the inspection chamber affords easy access, and in the event of a stoppage, it can be seen where it is, whether in the sewer or in which of the drains.

That a stoppage in one house-drain does not inconvenience an adjoining house.

That the system is less costly than that of having a separate drain laid under each house.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The intercepting syphon is accessible and can be cleaned out by the hand, while a square junction is used for an air inlet in preference to holes in the cover, as behind cottages small stones are often dropped through the holes, and the junction allows of their accumulating and being cleaned out before getting into the chamber. In better houses an iron pipe with mica flap-valve could be used.

When a stoppage occurs in an old drain, it is usual for owners, in order to avoid the cost of removing the obstruction, to assert that it is in the back sewer, and that it may be possible to prove at once whether this be so or not, an inspection chamber is made at the end of such sewers.

### Inspection and Testing of House Drainage.

A tracing of the block plan of a building application, showing the drainage as approved, is gummed into a pocket-book, which the inspector has always with him, and makes it possible for him to carry it out as approved, or to mark and preserve a record of any deviation therefrom.

When the length on the road is put in, the inspector explains any point he may think necessary, so that when he comes to make the test, the arrangement of the drainage is such that he can approve it.

The length on the road is usually tested separately, and then the remainder of the drains in one or two portions, according to the size of the house, all traps having been set, and the first length of soil-pipe fixed.

The testing blocks are discs of steel which, by screwing closer together, press out against the inside of the pipes an indiarubber ring, the end of the drain pipe and the inlets are thus easily made watertight. The pipe through the disc either lets in water by a flexible hose attached to any tap by a "Royle's union," or if left open lets out air until the pipe is filled with water, when it is capped for the test to be made. The bye-laws provide that drains are to be laid watertight, and it is to prove this that testing them with water is adopted.

There is now no inducement for unprincipled workmen to make the joints on the top side, leaving the under part of the joint open; or for builders to use cheap porous pipes through which water can ooze.

Into other details of house drainage the author has no wish to enter. He regards the water testing as invaluable, and if done promptly incapable of causing irritation.

## DISCUSSION.

Mr. A. M. Fowler: The only thing I see about the plan is that so many houses are drained into one well or hopper. Supposing one of these 6-inch pipes got stopped up, it would be very awkward for the other residents who go into the drain to have their drainage broken up. My own plan has always been to have a separate drain for each house.

Mr. J. S. Brodie: I shall be glad if Mr. Walker will tell us if his Board purchased the land shown for the passages in which the drain common to eight houses is laid, as it seems to me to be unreasonable to compel the owner of the property to provide land gratuitously for a public sewer. I take it that no charge is made for wayleaves under the gardens or yards, where the public sewer is laid, at the back of the premises. In regard to the merits of the combined system of drainage described in the paper, it appears to be open to the serious objection that no provision is made to prevent excremental infection discharged from one house spreading to the other three houses draining into the same inspection chamber.

Mr. W. H. Savage: Under the Public Health Act of 1875, the sewer does extend to the third house. In my district I adopt this plan very much, but I put an inspection chamber on the footpath in front of the houses, and another at the junction at the back, besides others along the back. I am certainly of opinion that the fewer drains you have under houses the better. I allow even as many as twelve houses to go into one pipe—a 6-inch pipe—and I regard it as a sewer and so deal with it.

Mr. J. Mann: I have much pleasure in seconding the vote of thanks to Mr. Walker for his valuable paper, which would have been of even greater value previous to the passing of the Public Health Amendment Act, 1890, which has modified the definition of sewer given in the Public Health Act, 1875. The plan suggested to a great extent met the difficulty as to separate house drains, which it was desirable to obtain wherever practicable. It was, however, quite open to discussion as to the advisability of

insisting upon separate drains if there was no alternative but laying them under the houses, and the plan adopted by Mr. Walker is in my opinion preferable to that, and is certainly less costly. The plan clearly shows separate connections from the inspection chambers, and another inspection chamber at the end of the straight length laid down the passage would be an improvement, but that is an item of extra cost, and from my experience I find that many improvements may be suggested by us in the performance of our duties, but no doubt other members present have experienced the same difficulty that I have, viz. that persons affected object to carry them out on the ground of expense. If the drains as shown were laid with an efficient fall there would be little trouble. I think we are indebted to Mr. Walker for the paper he has given us.

Mr. J. Lobley: The plan proposed by Mr. Walker is much better than the carrying of a drain under each house.

Mr. Fowler (interposing): Do not let me be misunderstood. It must not go forth that I want a drain under the house at all.

Mr. Lobley: You take these eight houses as they are, you find them there, and you have got to drain them, and the alternative to taking a drain under each house is something of this kind. For the last thirty years I have adopted some such method. The system of taking a drain under a house is rare in the north, but there appears a good deal of it in the south. The only novelty of Mr. Walker's plan is that instead of joining the 4-inch pipe to the 6-inch pipe, in the entry the shortest way, he takes it to the inspection chamber. He lays all the four branches to the inspection chamber, where they are brought to a focus, and it can be seen where the stoppage is. Until 1890 that sewer up to the inspection chambers became vested in the Authority and was cleansed and maintained by that Authority. The Act of 1890 introduced a number of very valuable provisions, among them being one which has solved the knotty problem as to whether that sewer should be charged to the Authority. By that Act, which requires to be adopted by the Authority, it may be charged to the owners, but the cleansing must devolve upon the Authority.

A Member: The maintenance can also be charged.

Mr. Lobley: I do not read that the law is altered in that respect. I believe it is only as to the making.

A Member: That is so.

Mr. Lobley: The Act is so recent that that question has not

arisen, but it is clear that the cost of executing any works under section 41, Public Health Act, 1875, can now be charged on the owner. I gather from Mr. Fowler's explanation that he would not construct houses on this principle, and in the North of England we should not allow houses to be built in this way. Under our bye-laws and under those of the 1890 Act, we are able to insist upon a separate back way or "secondary means of access for the removal of house refuse and other matters." I am sorry to hear that with Mr. Walker such a system of construction as shown on the plan is still permitted. With us no house erected within the past thirty years has been built without a separate backway, and I need hardly say that most of our houses command much less rents than those shown in front of us.

Mr. J. Hall (Cheltenham): It appears to me that the whole system is really a retrograde step. I therefore agree with Mr. Fowler, though I would almost carry it farther than he does. My practice has been not to contemplate any drain under a house at all, but when an owner brings his plan, I say "We are not prepared to approve of that, and if you wish it you must compel us to approve." The inspection chamber in this plan is put on private property, where there might have to be payment for entry and for way leave to get to this inspecting chamber. That is sufficient to condemn it. I think it is much better to insist that each house shall have its own private connection with the sewer, and that we should not discuss this question with the speculative builders as to whether a plan of drainage is to cost 5½*d.* or 6*d.*, but to consider whether it is consistent with the public interest that it should be approved or not, and decide accordingly.

Mr. W. Weaver: A short time ago I was called into a district where the combined system of house drainage as shown on Mr. Walker's plan was generally adopted. The houses as a rule had no basements, and to save expense the forecourts were drained through apertures cut in the kerb supporting the garden railings. The water, etc., flowing through these holes, made the footpaths untidy, and, where gravelled, wore the surface into channels, and in other places where the paths were paved, such water was frequently frozen, making transverse slides across the paths. In a combined plan, as shown, it is possible for a bath sponge, entering the first or higher drain, to cause a stoppage just before the manhole chamber, and thus block the drainage of three or four houses—an awkward thing if a deluge of rain is falling. At such times work-

men are not always obtainable, and considerable damage may result before the stoppage is removed. I can readily understand that, in country districts, where land is cheap, and the houses built with plenty of garden spaces at sides and in front, and with reserved common back passages, that in such cases combined drainage may be carried out with a minimum of risk and a maximum of economy; but in London, with land fetching perhaps 100,000*l.* an acre, it is impracticable to carry out a similar system, and it would be extremely unwise to attempt it, even if it were practicable. Prior to the year 1856, combined drains were frequently laid down in Kensington, and at the present time they are being abolished, and separate drains laid to each house. The latter system is in my opinion the proper mode of drainage for a crowded town district. Let each house bear its own burden; don't let the careless occupier jeopardise the comfort of his careful neighbour. If a sound, hydraulic-tested drain, bedded on and covered with cement concrete, is taken under a house, I fail to see the risk to the health of the occupants. In conclusion, I would say one word relative to the metal discs or stoppers used by Mr. Walker. I have found in practice considerable delay to arise in testing, owing to the drain pipes not always being circular; the disc has then to be made tight with plaster, and time allowed to set, and so forth. I now use indiarubber bags inserted into the mouth of the drain, and filled with air by a force pump, and I find these inflated plugs or bags much better than the discs formerly used.

Mr. Eayrs: Referring to testing, I am now using the indiarubber bag, but don't find it a success. I have had cases in which on filling the drain with water the bag has been blown completely out of the pipe. When you put a heavy pressure of water on it I find the bag will not stand it at all. There appears to be a great diversity of opinion as to house drainage. Probably in the North of England they would not allow houses to be built in the manner shown on the drawing before us. They would require a back road to every house, and no doubt that is the best system to adopt, because you can then have a separate drain to each house. But when you come south, you find that streets have been laid out for grouped drainage, such as we see here. We have to deal with cases as they arise. This is a very common form of property in the Midland counties. In all cases where new drains are laid under houses I insist upon a cast-iron pipe; but I never allow a drain to go under a house where it can be laid elsewhere. In my district we are

subject to mining subsidences, and the putting of drains under the houses would be disastrous. I have one case where the street, houses and everything, has subsided 13 feet 8 inches, so it is utter disaster to any drains, even cast-iron pipes might be fractured. All the members who have spoken appear to agree that the drain down the entry from the sewer to the inspection chamber is a public sewer. I suppose they take it under the interpretation clause of the Public Health Act, 1875. That may be so, but a point arises upon this particular plan. It appears from this plan that the entry is common to all the houses, and it occurs to me whether there is not a common curtilage.

Mr. Lobley: That is not so; you must not assume that.

Mr. Eayrs: I only assume it because the ashes of the houses would have to be removed, and they would not take them through each house when they have a common passage; but even if it is not so, then I think that the reference to private drains in the Public Health Amendment Act, 1890, may throw some further light on the subject. My Authority are unwilling to assume that this is a public sewer. Difficulties will arise constantly, there is no doubt about it, and this is the first time I have heard it publicly stated that any Authority has adopted them, and recognised them fully as sewers up to these inspection chambers. I think that is hardly fair and right. I think the drains on private property should belong to private owners. We are unwilling to take that responsibility, and we are having some difficulty with owners. There is another point with regard to the plan. I should have liked to have seen a few more straight lines about it. The drains are not as straight as I like them. Instead of turning corners with bends as is usually done, I have adopted a system of putting in a junction, and then a bend, putting in a disc block at the end of the junction which allows of the drain being opened at all turns for cleansing without breaking up any pipes.

Mr. J. P. Norrington: I may say that in London, in quite 75 per cent. of the cases, the house drainage has to pass under the houses, and the Vestry I am the surveyor to, insist upon the system of each house having a separate drain communicating directly with the main sewer. The Vestry is continually receiving complaints where the drainage has in past years been allowed to be constructed on the combined system, and the stoppage in the house drains is, in the first instance, invariably attributed to a defect or stoppage in the main sewer. The result is that unless you have

properly constructed separate drains to each house, whenever any trouble arises, I have to cause the sewers to be examined, and prove that the defect is connected with the house drainage. In these cases the Sanitary Department have also the greatest possible difficulty in finding out where the defect is, and who are the persons really responsible for making the necessary repairs. This causes a great deal of trouble and loss of time before the repairs are made, and in the meanwhile the occupiers of the property have incurred very considerable risk and danger. The plan submitted by Mr. Walker is certainly not one which would be approved in my district, or one which I should like to be published as meeting with the approval of this Association. If, as a surveyor to a parish, I allowed the combined system shown on the plan at all, I should want (1st) a separate syphon trap to the drainage of each house; (2nd) an inspection chamber at the head of the main drain to the sewer, so that that portion of the main drain leading direct to the sewer might be readily cleansed; (3rd) the drainage of the two houses immediately adjoining the central passage should not be taken backwards, but in the direction of the flow to the additional inspection chamber I have already suggested. In connection with the system of separate drainage for each house, I insist upon an inspection chamber at the back, from which the sewage is carried in a direct line to the sewer, and wherever possible I have another inspection chamber in the forecourt of the house, with the syphon trap in front of it, and accessible from it. The Vestry has also lately endeavoured to obtain a ventilating pipe carried up the front of the house, above the eaves, from a point in the drain between the syphon trap and the main sewer, so as to assist the ventilation of the main sewers.

Mr. W. H. White: It appears very undesirable that a Local Authority should be saddled with the expense of house drainage in any shape or form. It therefore occurs to me to ask whether, when plans for houses are passed, a stipulation could not be made with the builders, which would be binding, that the maintenance of these drains shall always be the liability of the property owners; or to put it in another way, that the Local Authority should contract itself out of the Act. With reference to Mr. Weaver's remarks, I cordially agree with him in preferring a drain being laid under every house, with an inspection chamber back and front, and if the drain is laid with cast-iron lead-jointed pipes, or with stoneware pipes surrounded with concrete, and

proper trapping and ventilation carried out, I fail to see any difficulty or objection. I agree with all that has been said as to the trouble caused by the combined system of house drainage. There is hardly a month passes in my city but difficulties arise from combined drainage, and the people always come to me to get them out of their troubles. The result has been that my Corporation has put its foot down, and says it will allow no combined house drainage whatever in future.

Mr. Parry: I am strongly of opinion that the drainage of eight houses through a pipe is better than from a single house.

Mr. Ellice-Clark: Why?

Mr. Parry: Because there is a better flow. As regards the responsibility of maintenance, the Corporation of Reading really do contract themselves out of the Public Health Act by a clause in their private Act of 1881. By this clause it is agreed that when an arrangement of this kind is entered into by owners of several houses, with the consent of the Corporation, the drain shall continue to be a private drain, and not a sewer within the meaning assigned to the word "sewer" in the Public Health Act, 1875.

The President: I am sorry to have to curtail this discussion, as this paper seems to have been one of considerable interest. It is not, I may say, exactly the plan of drainage I should adopt. I am very much opposed to grouped drainage, especially in districts where the separate system is adopted. The plan we have here is evidently got up roughly. I have no doubt Mr. Walker will tell you that the drains would be laid in straight lines.

Mr. T. Walker: Many of the queries have been replied to by subsequent speakers. We do not in Croydon lay drains on straight lines, but turn corners with slow or eighth bends, so that drain rods will pass easily round them. As to testing the drains by the plugs, we often test ten a day, and have not a failure once a month in getting the plugs watertight. The idea was got from the Health Exhibition. We think them very excellent, and they have saved a great deal of time. As to easements in Croydon, we have not paid a penny as easement for sewers, or for damage done in opening down to them, for twenty years. If you leave premises in a better state than you find them you ought not to be asked to pay anything. As far as our practice is concerned this plan is a copy of an application we had before a recent committee; it shows the maximum number of houses we allow to be drained together. They all belong to one owner, and the adoption of this plan avoids the inconvenience and

undesirableness of drains passing under each house. Drains can be laid in a perfect manner, but when we have to deal with builders we know the difficulties there are in getting them so laid. It is only six months ago that our Corporation decided they would take these combined drains which are laid in the passages to the backs of the houses, and consider them to be public sewers. In doing this, in the way we have them laid we are not incurring much expense. If you have them laid properly I have no hesitation in saying they will entail very little cost in maintenance, I would rather have them laid on this principle, and be responsible for the sewer-lengths, than have separate drains passing under each house. In Croydon we have very deep back gardens, and in place of 60 or 80 feet of drains to be laid from each house to a sewer in a back road, I consider a short run to the sewer on this principle much more satisfactory to both Corporation and owners. Each house is drained separately into the inspecting chamber, the lid of which can be removed in an instant if need be, and drain rods passed down the drains. All houses have water-closets, and in cottages the dry ashes are carried through the houses. This plan is only for cottage property; for villas there can be separate drainage down a passage and this method of drainage does not apply.

Mr. Fowler: Does the block return at the end?

Mr. Walker: No, this is in a street a quarter of a mile long. We should refuse to sanction plans unless they provided a passage for the drainage.

# CREOSOTING TIMBER.

By E. J. SILCOCK, Assoc. M. Inst. C.E., F.G.S., Borough Engineer, King's Lynn.

In bringing the subject of creosoting timber before this Association it is hardly hoped that any new matter will be introduced.

The whole subject has been most fully discussed by Mr. S. B. Boulton, A.I.C.E., in his paper on "The Antiseptic Treatment of Timber," read before the Institution of Civil Engineers, and the author acknowledges the great assistance which that paper has been in the preparation of the present communication.

Although the subject has been so fully dealt with, the author finds no generally accepted practice, and having had some little experience of the work, hopes by means of this paper and a fresh discussion to ensure a greater uniformity in the specifications issued by the members of the Association.

There is at present such a variety in the requirements of different specifications that it is practically impossible to comply with all with the same plant. The result of this no doubt very largely is, that when firms are putting down creosoting plant they only provide for the requirements of the majority of their customers. Now, unfortunately, this majority is usually that section which is somewhat lax, and contractors take alike all orders with the hope that they may be able to get their work passed even in cases where their plant cannot carry out the specification.

At present a good specification and thorough inspection are met with the declaration that there is no available plant in the immediate neighbourhood, and that we must therefore be satisfied either with getting what we can or send to a distance. Now, independently of the extra expense, this alternative renders thorough inspection extremely difficult, and is generally opposed by contractors or our clients.

We all know there can be practically very little difference in the labour or time required to do the work efficiently or the reverse, and it is therefore evident that if there were a more uniform system of specifying, combined with more rigid inspection, the supply

would soon meet the demand, for creosoting firms would speedily put down suitable plant for the work. No difficulty would then be experienced in getting what we require.

The importance of having timber creosoted when it is to be subjected to the influences of the weather hardly admits of argument. Abundant evidence can be produced to show that where efficiently done the process at least doubles the life of timber.

One or two facts on this head will suffice. The average life of an ordinary uncreosoted telegraph pole is, on the authority of Mr. W. H. Preece, F.R.S., Chief Electrician to the Post Office, about seven years, whereas a line of creosoted poles about 20 miles in length put down in 1848, were taken up in 1883, and were then perfectly sound. Again, on the Great Western Railway it is found that the life of uncreosoted sleepers is five years, and that of creosoted sleepers eight to ten years, and many last to double that length of time. In tropical regions timber is very rapidly destroyed by marine insects, more particularly the *Teredo Navalis* and *Limnoria*. On the Pacific and Atlantic shores of the States it is found that uncreosoted piles are destroyed in two years, whereas creosoted piles last from five to six years.

Since then the process doubles the life of timber, and the cost of treatment is not more than 20 per cent. of the prime cost of the material, it is a self-evident proposition that all exposed timber should, where possible, be creosoted. If we add the cost of carpentry, driving and fixing the material, to the prime cost, the case for creosoting is even stronger, in most cases not adding more than 10 per cent. to the cost of complete work. Many works carried out by members of this Association involve the use of large quantities of timber, so that the importance of the subject in this regard should not be overlooked.

Without going very deeply into chemistry, it may be stated that what is commonly called creosote is that portion of the products of the destructive distillation of coal tar which is heavier than water. When coal tar is distilled, three groups of products are produced, viz. (A), crude naphthas or oils lighter than water; (B), dead oil or creosote, heavier than water; and (C), pitch.

These oils contain many constituents, between which there is no clear dividing line, but the constituents of creosote may be divided into three groups: 1st, the phenols or most volatile portions, the chief of which is carbolic acid; 2nd, the group the principal of which is naphthalene; 3rd, the least volatile or bituminous

portions which distil over at a temperature beyond 535° F., the principal of which is anthracene.

Decay of timber is brought about chiefly by three agencies, viz. by the fermenting of the albumenoids of the sap, by the admission of water into the cells of the wood, and by the attacks of insects. In all three directions creosoting acts as a preservative.

The carbolic and other acids in the creosote coagulate the albumen of the sap and arrest the process of fermentation; the heavier portions of the creosote enter and fill up the pores of the wood, and so prevent the entrance of moisture; and the powerful smell of the creosote, and probably its flavour, deter insect life from penetrating the wood and taking up its abode in its cells.

The modern germ theory has entirely revolutionised the accepted ideas of scientists on the subject of the putrefaction of animal and vegetable tissues.

It was formerly believed that the coagulation of the albumenoids in these organic tissues permanently prevented putrefaction. It has, however, been demonstrated that the coagulation of albumenoids is not permanent, and that antiseptics (germ killers), which (like carbolic acid) are themselves soluble in water and volatile in air, are removed from their albuminates by the action of water and air, and so permit germ life, or fermentation, to set up.

M. Pasteur has now clearly demonstrated that germs are the agents of decomposition, and that in their absence organic decomposition does not take place. Various kinds of fermentations, such as yeast, vinegar, beer, &c., have been traced by him to a specific germ, which can be detected and cultivated and relied upon to produce its special kind of fermentation.

In attempting, therefore, to preserve timber we must select such substances as will be capable of killing these organisms known as germs, and will produce such conditions as to prevent their development.

Carbolic acid (a phenol), though a very powerful germ killer or antiseptic, is unfortunately very volatile in air and soluble in water, and several investigators have proved by analysis that it is present only in extremely small quantities in timber twelve months after treatment by creosoting.

It would therefore appear that the extreme value of this acid, which was formerly so much insisted on, is somewhat doubtful. Still there can be no doubt that the coagulation of the albumen which is effected at the commencement of the process is of value,

especially as air and water are afterwards prevented from reaching the interior of the wood by the more bitumenous portions of the creosote oils.

The naphthalene group forms a large proportion, about 60 per cent., of the constituents of creosote oil, and has antiseptic powers, though they are less energetic in their immediate action than carbolic acid. Naphthalene itself is, however, practically insoluble in water, and is very much less volatile in air than the phenols, and at ordinary temperatures it solidifies and tends to prevent the escape of the more volatile portions of the oils, and the entrance of moisture and micro-organisms.

Dr. Tidy made experiments with a view to determining the extent of volatilisation of naphthalene, and he was led to the conclusion that the loss was very rapid for a day or two, but after that period it decreased to almost nothing. This result has, however, not been verified by Dr. Clark, who recently read a paper on the permanency of creosoting agents; he found that volatilisation went on to a large extent for a very considerable period.

This view accords with actual experience, for it is a very common thing to see the soil round sleepers discoloured by creosote twelve months after they are laid. Naphthalene must not therefore be looked upon as an absolutely stable body.

Experiments are now being made in America with naphthalene alone as a preservative, but so far as the author knows no results have yet been published. There is, however, a practical difficulty in use of pure naphthalene, as its melting is about 173° F., and therefore it must be raised to a very considerable temperature before injection.

Turning now to the heavier or more bituminous portions of the creosote, viz. those which distil over at a temperature beyond 535° F., we find that their function is almost entirely confined to forming an impervious skin or shell round the timber, and to this Dr. Tidy attaches special importance, for in his specification he stipulates that not less than 25 per cent. of the oil should distil beyond 600° F.

Creosote oils are divided into two classes, known as London or heavy oils, and Country or light oils. The London oils are those obtained from coal tar made from Newcastle coal, whereas the Country oils are made from coals from the Midland coalfields. The London tars yield less tar acid or phenols than the Country

tars, but they contain more naphthalene. In ordinary commercial creosote the phenols vary from 3 per cent. to 18 to 20 per cent.

In considering the constituents for which it is necessary to specify in creosote, we find that formerly as much as 12 per cent. of phenols was sometimes specified. It appears, however, that a very much smaller proportion of phenols will effect the coagulation of the albumenoids which is at first required, and that if a greater quantity is provided it very quickly volatilises.

It should be noted that the quantity of tar acids should bear some relation to the quantity of sap in the timber, so that for telegraph poles, hop poles, and similar young or sappy wood, the tar acids should be greater than for deals and whole timbers.

Generally, however, it appears now to be the opinion that if 5 per cent. of tar acids are present, it will be sufficient for ordinary cases.

The percentage of the heavier or pitchy constituents of the oil is also important. It is this portion which blocks up the pores of the timber. Dr. Tidy, as previously stated, specifies 25 per cent. of these constituents which do not distil under 600° F. This, the author submits, is impracticable, as from several analyses of commercial creosote he finds that the residue at 600° varies from 8 to 15 per cent. Probably 25 per cent. over 535° F. is about as much as is obtained in practice.

At the same time the oil should be completely liquid at a temperature of 100° F., or it cannot be injected sufficiently freely into the fibre to form the skin or shell before referred to.

No ammoniacal water should be present in the creosote, as it has an injurious effect upon the timber.

It is the practice of some firms to mix crude tar with their creosote oils, especially if they use country oils. This course should be deprecated, as the crude tar contains all the oils lighter than water, which are of no value for creosoting purposes, and also a large quantity of pitch, the carbon in which prevents the oils from penetrating the fibres of the timber.

Occasionally bone oils and mineral oils are used for creosoting purposes, but as they contain no antiseptics they are unfit for the purpose, and should be rejected.

In America creosote proper, i. e. oils obtained from the distillation of wood, are largely employed. This no doubt arises from the fact that timber is much cheaper in America than in this country, whereas coal is much more expensive. Wood creosote is much more

uniform in its constituents than coal-tar creosote, and is less volatile and soluble when exposed to air and water; it also contains no ammonia, which is considered to hasten decay. It is said to be much more effective in protecting timber from marine insects than coal-tar creosote.

The quantity of oil to be injected varies in most specifications from 6 lb. per cubic foot to 12 lb. per cubic foot. Generally it may be said that the more creosote is injected the more efficient the process, but of course when this principle is carried to excess the expense becomes prohibitive, and it is found that except in the case of very young timber, or of very small scantlings, 12 lb. per cubic foot is about the practical limit. The author has, however, seen Baltic sleepers, 10 inches by 5 inches, which absorbed over 20 lb. per cubic foot, so that although for large scantlings it may not be possible to inject such a large quantity as this, still there is no practical difficulty in getting 10 to 12 lb. injected into any timber of the coniferous class.

The specific gravity of creosote being about 1·05, a gallon weighs 10½ lb., and the author submits as a standard that one gallon per cubic foot should be required, as it is more convenient to measure the quantity in gallons than in pounds.

The processes by which creosote is injected into timber in this country are four in number, viz. the Open Tank process, Bethell's process, Boulton's process, and Blythe's process. These will now be described in the order named.

Of the Open Tank process very little need be said; it consists merely of steeping the timber in creosote in an open tank. Unless the process is carried on for a very lengthened period, say several weeks, and the oil is kept at a high temperature, it does not penetrate beyond a very short distance from the surface of the timber, unless there is a large proportion of sap-wood, or the scantlings are very thin. A few shavings with a plane will entirely remove all traces of creosote from the heart-wood. This process, therefore, cannot be said to be very satisfactory.

In Bethell's process the timber is placed in closed iron cylinders. varying in length from 40 to 80 feet, and in diameter from 4 to 7 feet. The cylinders have hemispherical ends, one of which is loose and is suspended from an iron arm fixed to the cylinder, so that during charging and discharging it can be swung on one side. The cylinder is provided with a faced flange at the end which opens, and the hemispherical end is secured in its place by screw-

clamps which clamp the end to the cylinder flange. The creosote is contained in a tank or tanks underneath, or to one side of the cylinder, and the tank and cylinder are connected by an iron pipe led from the bottom of the cylinder, and provided with a stop valve. Hot-water or steam pipes are taken from a suitable boiler and furnace into the creosote tanks, so that the temperature of the oil can be raised to 120° F. before admission to the cylinder. An air-pump and a pressure-pump, driven either by steam or hydraulic power, are placed in a shed adjoining the cylinder; the air-pump being connected to the creosote cylinder by suitable piping, and the pressure-pump drawing its supply of creosote from a tank and discharging into the creosote cylinder. It is preferable, if possible, to have a separate tank for the pressure-pump to draw from, as the quantity of creosote injected can then be more accurately measured.

The process is then carried out as follows: the timber is placed in the cylinder, the hemispherical end fixed, and the air-pump is set to work to exhaust the air from the space unoccupied by the timber and from the pores of the timber, the valve between the cylinder and the creosote tank being closed and a vacuum of about 10 lb. per inch being maintained. At the end of an hour the valve is opened, and the atmospheric pressure causes the creosote to rise up the pipe connecting the cylinder and tank, and fills up all spaces in the cylinder not occupied by timber.

When the tank is full the air-pump is stopped and the pressure-pump is set to work, and creosote is pumped in under pressure until the required quantity has been injected into the wood. The time occupied in this operation depends on the quantity to be injected and the state of the timber, varying from ten minutes to as many hours, the pressure varying from 30 lb. per square inch up to 120 lb. per square inch.

The quantity to be pumped is determined by multiplying the cubical contents in feet of the charge of timber by the specified quantity of creosote per cubic foot. The tank from which the pressure-pump draws its supply is provided with a gauge by means of which the quantity pumped can be measured.

When the required quantity of creosote has been injected the pump is stopped, and the valve connecting the cylinder with the creosote tank is opened, and the oil is allowed to drain back into the tank. The cylinder is then opened, and the charge of timbe withdrawn.

Boulton's process differs from Bethell's in that the temperature to which the oils are raised in the creosote cylinder is 212° F. to 220° F., instead of 120° F. To effect this, steam pipes are introduced into the creosote cylinder. The plant required is similar to that for Bethell's process, except that, besides the above-mentioned steam pipes, a steam dome is fitted to the cylinder and a surface condenser to the air-pump.

The principle on which the process rests is the fact that whereas the boiling points of the creosote oils vary from about 250° F. to 700° F., that of water is 212° F., consequently all the moisture present in the timber is driven out in the form of steam by the heat of the oils, and this steam is exhausted by the air-pump and subsequently condensed without any appreciable quantity of creosote being evaporated. At the same time the timber does not suffer from this excessive heat, because that heat is applied through the medium of the oils, and is not a dry heat.

The process is carried out in the following manner: as soon as the cylinder is charged with timber and closed, oil is introduced until the cylinder is nearly full, and the temperature raised to 212° F. to 220° F. The air-pump is then started, and the air and steam exhausted until no further water flows from the condenser. The pressure-pump is then worked until the required quantity of creosote is injected.

The timber absorbs a large quantity of oils by displacement as the moisture is driven out, so that the pressure-pumps have less work to perform, and less oil has to be forced in by that means, a clear advantage over Bethell's process.

The total quantity of oils injected is the sum of the quantity absorbed by displacement and the quantity injected under pressure. The first of these quantities is ascertained by completely filling the creosote cylinder and dome with oil before the air-pump is started, then reading the gauge in the creosote tank. A small quantity of oil is then run back from the cylinder into the tank, to secure a space at the top of the cylinder in which the air and steam can gather. When the exhausting process is finished, the cylinder and dome are again filled and the gauge again read. The difference between the two readings gives the quantity required, i. e. already absorbed.

The second of these quantities is the balance required to comply with the specification, and this is then pumped in by the pressure-pump from a tank fitted with a contents gauge.

P 2

Boulton's process is a very marked improvement on the older system, more especially when treating timber which has been water-seasoned, or which is very green. To put it in plain words, the timber is boiled in the creosote, and by that means all the water and most of the sap are removed, as well as the air from the cells of the timber, and the creosote oils take their place.

The advantages of the process are not so marked when treating deals or other sawn timber, which is usually fairly well seasoned and tolerably dry, but it is common practice to take Memel timber and pitch pine out of seasoning ponds, and put straight into the creosote cylinders.

In such a case Bethell's process cannot materially reduce the quantity of water in the timber; merely exhausting the air and reducing the pressure on the outside of the timber will not extract any large quantity of moisture, and when the pressure-pump is put to work and the creosote forced into the timber, the water is only driven more deeply in, and then sealed in by the bituminous portions of the oils. It will thus be seen that it may be quite possible, by using Bethell's process, to fix in the timber an element of danger to its durability.

Boulton's process is an improvement in another direction. Having extracted a large portion of the sap in the shape of steam, there is not such a large quantity of albumenoid matter to coagulate, so that the quantity of tar acids may be reduced, and oils of an inferior quality may be used without decreasing the efficiency of the treatment. This is important, as the tar acids are now very largely extracted from the creosote oils for other commercial purposes, and with ordinary London oils the percentage of tar acids is not as high as prudence would dictate if all the sap in young timber is left in.

The plant required for Blythe's process is somewhat similar to Bethell's, except that no air-pump is provided, and a steam injector replaces the pressure-pump.

Blythe's process, known as "Thermo-Carbolisation," differs however in principal from Bethell's and Boulton's. The oils in this system are applied first in a gaseous or finely-divided state, and subsequently as a liquid.

The process is carried out as follows:—

The timber is stacked in a closed cylinder, and superheated steam, at a temperature of 800° F., is supplied to the injector. The injector delivers into the bottom of the cylinder and draws its

supply of oils from a tank. There is also a pipe connecting the top of the cylinder with the injector, so arranged that the injector exhausts the gases from the top of the cylinder, and re-delivers them, along with fresh supplies of finely divided oil, at the bottom of the cylinder. In this manner a continuous circulation of gases is kept up for thirty minutes or longer, the temperature of the gases varying from 80° or 90° F. at the commencement, to above 212° F. The steam is then turned off, and the cylinder and contents allowed to cool.

If the timber is required for joinery or building purposes, the process stops at this point; if, on the other hand, the timber is required for underground or hydraulic works, the cylinder is connected with the creosote tanks, and oils are pumped in by steam pressure or ordinary pumps, as in Bethell's process.

The author has had no practical experience of this system, but it is claimed that it dries, hardens, and protects timber, the oils penetrating the heart as well as the sap-wood. The system is used by the Great Northern Railway Company, whose Engineer states that the results produced are similar to those obtained by Bethell's process.

It is difficult to see by what means the effects claimed are obtained. Circulating steam at a temperature of 90° to 212° F. around timber cannot, one would imagine, have a very drying effect, and as the boiling points of carbolic acid and naphthalene are 360° F. and 422 F. respectively, these bodies, to say nothing of the heavier constituents of creosote, cannot be in a gaseous state at all, although they may be in a very finely divided state, and so penetrate the pores of the timber.

Probably the most effective part of the system is the pumping in of creosote in the liquid state, as in the older processes.

All timber should be inspected before treatment, as it is practically impossible to judge of the quality of the timber afterwards; and a rigid system of inspection should be enforced to see that the provisions of the specification are carried out, for, except in the case of small scantlings treated by Bethell's process, which can be weighed before and after treatment, there is no method of checking the quantity of oils injected, except by an inspector being present during the treatment, and himself gauging the quantity of oil absorbed.

As far as practicable, timbers of similar scantlings should be treated at the same charge, e.g. 12-inch square timbers and

2-inch planking should not be treated at the same operation, or the planks will absorb more than their share of oil, and instead of the large timber getting the specified quantity of oil, it will be robbed by the planking.

It need hardly be pointed out that all carpentering operations performed on the timber after treatment, militate against the success of the process, and, by breaking through the crust of creosoted fibres, points of access for air, water, and micro-organisms are made. It is therefore desirable, as far as possible, to prepare the timber before treatment, and such structures as gates, troughs, &c., which can be introduced bodily into the pressure cylinder should be treated after completion. Where this cannot be done, all mortises and tenons, and other places where the uncreosoted parts of the timber are exposed, should be paid with coal tar before the joints are made.

Timber which is intended to resist marine insects is, where practicable, better employed in the round state, because the sap-wood more readily absorbs the creosote than the heart-wood, and this forms an armour against the worm.

The author submits for inspection a few specimens of timber creosoted by the different processes, to show the depth to which naphthalene and the heavier oils penetrate.

It will be noticed that sap-wood absorbs creosote much more readily than heart-wood.

*No.* 1 is a section cut from a red-wood post creosoted by the open tank process, the timber having been immersed for about a fortnight.

*No.* 2 is part of a section of a 12-inch by 12-inch Memel pile, treated by Bethell's process, with 1 gallon of oil per cubic foot.

*No.* 3 is a section of a Memel plank 11 inches by 4 inches, similarly treated.

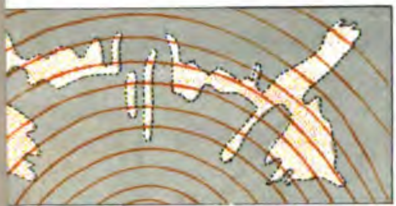
*No.* 4 is a section of a 12-inch by 3-inch red-wood plank, creosoted by the same process, but with 7 lb. of oil per cubic foot.

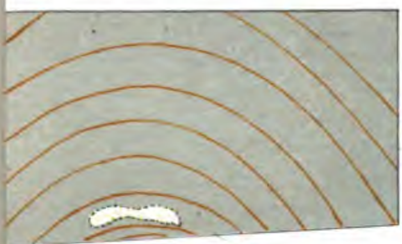
*No.* 5 is a section cut from the centre of a Baltic sleeper, 10 inches by 5 inches, treated by Boulton's process, with 7 lb. of oil per cubic foot.

*No.* 6 is a section of a similar sleeper, treated by the same process, but 1 gallon of oil per cubic foot has been injected.

*No.* 7 is a section of a sleeper, treated by Bethell's process, which absorbed creosote at the rate of 23½ lb. per cubic foot.

*No.* 8 is a section of a Baltic sleeper, 10 inches by 5 inches, treated by Blythe's process.





E.J. Silcock, C.E. Delt.

In conclusion, the author submits the following as a standard specification:—

The whole of the timber used must be creosoted with coal-tar creosote, which shall be completely fluid at 100° F., shall yield 5 per cent. of tar acids, and contain 25 per cent. of constituents which do not distil under 535° F. The creosoting must be carried out in the following manner: The timber must be placed in a closed iron cylinder fitted with a dome, an air-pump, and a pressure-pump, and capable of being heated. As much creosote must be admitted to the cylinder as will nearly fill it; the temperature of the oil must then be raised to over 212° F., and the air-pump put to work until all moisture in the shape of steam has been exhausted. The cylinder must then be completely filled with creosote, and the pressure-pump worked until a pressure of 100 lb. per square inch is produced, and the timber has taken up creosote at the rate of 1 gallon per cubic foot.

## DISCUSSION.

Mr. Laws, in moving a vote of thanks to the author of the paper, said: There is one statement of Mr. Silcock's which requires some modification. He says, "abundant evidence can be produced to show that where efficiently done the process at least doubles the life of timber." My experience, I am sorry to say, has not been quite that. I believe that where the timber is of poor quality, and contains a good deal of sapwood, its life may be doubled by creosoting. But the life of pitch pine and good timber will not be doubled or anything near it. In the case of pitch pine and sound Memel, I should only apply creosote for under-water work, or where the sea is likely to reach it, as in tidal rivers. With regard to the quantity absorbed, beech will take more creosote than any wood I know. It is very easy to get 24 lb. of oil into the cubic foot. The details of the various processes which Mr. Silcock gives are extremely interesting, and I think his paper is well worthy of the Association.

Mr. J. P. Norrington: I am very pleased to second the vote of thanks to Mr. Silcock for his exceedingly carefully prepared and interesting paper. I do not know that I have any observations to make upon it, except that I generally agree with the conclusions of the author. I have had to do a great deal of creosoting for

wood paving purposes, and the specification I have worked to is very similar to that which is suggested by him. My specification provides for the creosote in the cylinder being raised to a temperature of 220° F., instead of 212° F., and I insist on the creosote being forced into the wood at a pressure of 120 lb. to the square inch, instead of 100 lb. mentioned in the paper; and to the extent of 10 lb. of creosote to the cubic foot of timber, which is practically the same as the one gallon suggested by the author (the gallon of creosote weighing $10\frac{1}{2}$ lb.). There is no difficulty in getting 10 lb. forced in per cubic foot, as frequently samples tested by my inspector have shown as much as 15 and 16 lb. I have always been very careful on this point, and the contents of each cylinder have been tested, and the particulars forwarded to me by my inspector. I have also been careful to have each supply of creosote analysed by a chemist, and obtained his certificate as to quality before I allow it to be used. Perhaps the most important point of all is to have a good and reliable inspector (or if necessary two) at the creosoting works, to see the cutting of the wood, and to weigh samples of all of it before being placed in the cylinder, and after being taken out. You will also find that he will have to prevent, owing to unsoundness or other defects, 15 per cent., or even more, of the wood blocks being placed in the cylinder.

Mr. J. S. Brodie: My experience has been, more especially with pitch pine, that there has been very little prolonging of the life of the timber at all. Then as to specifications for the creosoting of the timber, I have generally specified for the timber to be artificially dried, so as to take in as much creosoting as possible. I find it will always take in 10 to 13 lb. to the cubic foot. In sawing beams I have generally found the creosoting well into the heart of the timber, though I do not say it is equal to No. 7. This is a most valuable paper on the subject, for which I thank the author.

The President: In asking you to accord to Mr. Silcock the vote of thanks which has been proposed and seconded, I should like to make a few remarks, but as time is so short I must be exceedingly brief. I consider that this paper is one which we ought not to dispose of in such a short time, as I have no doubt there are many gentlemen who would like to discuss it more fully. When I was commencing my career as a pupil, I was employed on bridge work, and had to see that the timber was properly creosoted. I will ask Mr. Silcock if, after the piles have been in use for a few years, the worm does not attack them. I found the worm entered

the timber in a short time, but I do not rely upon the cases I refer to, as I am not satisfied that the creosote was properly applied. It is important that the timber should be inspected before the creosote is applied, as sap cannot be detected afterwards.

Mr. Silcock: I am extremely obliged to the members for the vote of thanks they have passed. In reply to Mr. Laws, I cannot say I have tried any beech. Beech is not a wood which comes much into engineering work. With regard to wood paving, I do not think there would be any difficulty in getting 25 lb. of creosote into a cubic foot, because there is a good deal of oil driven in at the ends of the blocks. Where you get large logs you have nothing like so large a surface to operate on. With regard to the artificial drying of pitch pine, I cannot agree with Mr. Brodie there. If you get dry heat to the timber you are very likely to injure it. If you use this system of Boulton's you apply the heat through the medium of the oils, and thus abstract the water without injuring the wood. The cost is not great—the interest on capital locked up in wood seasoned outside the tanks would come to a great deal more. I think you, Mr. President, put the pith into your remarks when you said, "Perhaps the process was not properly applied." I should say that was so. I have done creosoting which is subject to the washing of salt water twice a day. I find it will not absolutely protect it from the worm, but it does prolong the life of the timber a great deal.

# ON THE RELATIVE MERIT AND COST OF GAS AND ELECTRICITY FOR LIGHTING PURPOSES.

By W. H. Preece, F.R.S., M. Inst. C.E.

I have the pleasure this morning of bringing before you the subject of the relative merit and cost of gas and electricity for lighting purposes, and as a practical man speaking to practical men, I purpose to consider the subject solely from a practical point of view, and to deal rather with the financial aspects of the question than its mere technics.

Of course I shall have to handle figures, and figures are proverbially dry. It has been said that you cannot extract a joke out of figures, and that you can always manipulate figures to suit your own particular view. Neither statement is quite true, because we have all of us heard the old story about the two men contesting with each other, and one man saying: "Why, sir, it is as plain as two and two make four," and the other man saying, "But two and two don't make four; two and two make 22." And, again, as to manipulating figures to suit one's own purpose, I dare say it will be said I am going to do very much that kind of thing myself. I am addressing you, if I have any prejudice at all, as a gas shareholder, and not as an enthusiastic electrician. My sole object is to get at the truth. Comparisons of cost are generally fallacious, because the comparison depends so very much upon the point of view taken.

The questions we have to decide are principally such as these: what is the capital involved, in any particular industry; what is the profit derived; and what has the consumer to pay? I am not going to bring before you any fanciful figures. They are published figures, and they are figures you can all get for yourselves, and you will be able to check the deductions I am going to make.

I have taken the case of Manchester for the simple reason that I have more authentic records of what is done in Manchester than I have of what is done in any other town. And, from the records of the gas department in Manchester, it seems that one ton of coal

in Manchester produces 9611 cubic feet of 20 candle-power gas. I take Manchester, also, because the quality of the gas there is above the average—20 candle-power gas is much in excess of the average of the country; the average of the country is not more than 15 candle-power. Since this is the quantity of gas produced by a ton of coal it follows that 1 lb. of coal will produce 4·29 cubic feet of gas, and if 4·29 cubic feet of gas is burnt per hour, we get in Manchester an illumination of 17·2 candles.

Now, in drawing a comparison between gas and electricity, I must use one technical term—and I think it probably will be the only technical term I shall use—and it is a technical term which is now coming into very general use, and will have to be understood sooner or later by every engineer, whether electrical or municipal —that is, the *watt*. A watt is the mechanical unit of power in the metrical system. The common unit of work with which we are most acquainted is the foot-pound, and the unit of power we know best is the *horse-power*—that is, the work done per minute which is equivalent to the raising of 33,000 lb. one foot. In other words, you may say a horse-power is the power which will raise 550 lb. one foot per second. The watt is that power which in the metrical system will raise ·737 lb. one foot per second. It is that power which is exerted by a current of one ampere flowing through one ohm for one second. It enables us exactly to tell you how many lamps will be lighted and what light they will give. So in the use of electrical energy, if we burn in a steam boiler 7 lb. of coal per hour, we shall produce 1·3 horse-power of electrical energy, or represented in watts we shall produce 1000 watts, and 1000 watts is called a kilowatt. So 7 lb. of coal will give us a kilowatt-hour of electrical energy, and I will show you what light it will give.

In the same way that I have shown that 1 lb. of coal distilled into gas will produce 4·29 cubic feet, or 17·2 candles of light, so 1 lb. of coal burnt in a boiler to produce steam will give us electrical energy that will give the following—I will show it in two forms: one, *the arc lamp*, which we use in our streets, and the other *the glow lamp*, which we use in our houses—1 lb. of coal burnt per hour and used as electrical energy, if burnt in the form of a glow lamp, will give 48 candles, and if burnt in the form of an arc will give 288 candles.

So here we start with the first fact that I bring before you, that 1 lb. of coal distilled into gas in Manchester gives us a candle-power of 17·2 for an hour, if converted into electrical energy in

the form of a glow lamp 48 candles, and in the form of an arc lamp 288 candles for the same period of time. That is theoretical; we will now come to hard facts.

In Manchester, during the twelve months ending March 30, 1890, the income derived from gas was 434,351*l.*, the expenditure was 360,804*l.*, showing that in Manchester a balance of 73,547*l.* was derived from gas. That balance was devoted to meeting interest on loans, depreciation of plant, and the cost of public lighting. But from that fact I derive this: that the cost per 1000 cubic feet of gas to the Corporation of Manchester was 2*s.*, and therefore it costs the Corporation of Manchester 2*s.* to produce 4000 candles of light for one hour.

For the next point I am obliged to use an estimate, for the simple reason that at present the Corporation of Manchester have not established a central electric light station. They have obtained a Provisional Order to enable them to do this, and they are now considering whether they shall carry it out themselves or transfer their powers to another body. In making an estimate of the cost of electricity in Manchester, we have to take the experience of the cost of manufacturing electricity elsewhere, and on this point there are at hand more reliable, accurate, and truthful figures than perhaps anything else connected with electricity. The Board of Trade exercise such a powerful control over the electric lighting interest, that there is no "hanky-panky" with the accounts. The accounts of expenditure must show the cost of production, and these are within the reach of every one.

My own experience of electricity is a pretty extensive one, for we have a great many of our post-offices lighted with the electric light, and I have a central station at the General Post-office, under my charge; we have there a very large plant and we are going to produce in St. Martin's-le-Grand sufficient power to light 10,000 lamps, besides which we are laying down another plant at Coldbath Fields, where we shall generate electricity for another 10,000 lamps—and from my own experience I can say we can produce a kilowatt-hour, or a Board of Trade unit, for 4*d.* This means that if we can produce 4000 candles by gas for 2*s.*, we can produce 4000 candles by the arc lamp for 8*d.*, and we can produce 4000 candles by a glow lamp for 4s. So you see, on these facts—I am not calling them estimates, for they are facts—on these facts the theoretical cost of light produced is twice as much by the glow lamp as by the gas lamp.

However proud we, as gas engineers, may be of producing gas of 20 candle-power, when you come to the houses and shops of the users and consumers you find this 20 candle-power is very considerably diminished. This is a very important question, and one which some six or seven years ago concerned us at the Post-office very much, and Mr. Vernon Harcourt, F.R.S., and myself devoted considerable time to experiments on this question. Mr. Vernon Harcourt—who is a very painstaking, careful, and accurate experimenter—found that the ordinary burner, supposed to be consuming 5 feet per hour and giving 16 candle-power in London, really gives only 10 candle-power, due partly to dirt in the burners, but principally to the flickering of the light of the gas, caused by draughts of air in the room. So, while a light burning in a special burner in a laboratory may give 16 candle-power, when you come to a room or passage that lamp will only give 10 candles. This *pro rata* value is equally true of Manchester as of elsewhere. The result is, you must add 30 per cent. to the cost of the gas for your 4000 candles.

I ought also to say this depreciation in the value of light is not only true in the case of gas, but also true to a certain extent in the case of electricity. The lamps when they are still fresh and new give 16 candle-power light, but after they have been used 200 or 300 hours there is a peculiar effect of the electricity flowing through the carbon filament that causes the carbon to evaporate—it flies away in straight lines and is deposited on the glass bulb, obstructing a certain amount of light. Again, you have a certain amount of dirt and dust collected on the outside. The consequence is you have a depreciation in the amount of your electric light, though not quite so much as in the case of gas.

I ought to mention, without drawing any distinction between the light-giving power—whether electricity or gas—in the light given by each, that five cubic feet of gas will give practically 10 candle-power, and 33 watts as the normal electric power will give you also 10 candle-power.

There is one element of loss in gas that is very serious indeed—that is, the tremendous waste that occurs through lights being left burning unnecessarily. Persons who have their houses and offices lighted with gas know that servants, as a rule, go and light all the burners, unless a careful householder goes round and cuts off those that are not wanted. The result is that from this very element of waste there is 20 to 25 per cent. of gas used more

than is necessary. This fact is brought out thus: taking the nine principal towns in this country, and taking the average numbers of hours of gas and electricity burnt, the average number of hours for gas is nearly 600, while the average number of hours for electricity is 460. The figure 460 is taken from the average of 200,000 electric lamps which are now alight in London. While in gas you have a tremendous waste from these burners being left flaring, you have no such waste from electricity. Electric lamps are so easily lighted—a tap turns them on and off—that there is a species of instinct that teaches everyone that you only want your electricity alight in the place where you are using it, and at the moment you are using it, and the result is you get no waste.

The result of it all comes to this: that the comparison between gas and the glow lamp is not 2*s.* as against 4*s.*, which is theoretical, but the practical figure of 3*s.* 8*d.* against 4*s.* We can prove this. The average amount, taking the returns from the nine chief towns of this country, paid per gas burner per annum is 9*s.*; the average price of gas being 3*s.* per 1000 feet. The average price of the 200,000 electric lamps burning in London is 10*s.* So we have these two facts: That the average price paid per burner by the consumer for gas is 9*s.* per annum, the average price paid by the consumer to the electric light provider is 10*s.*

This is a rather startling figure, because most people are under the impression that the cost of the electric lamp is very much greater than that of gas, and I have been myself very much surprised that the price I pay in my own house, where I generate my own electricity and have done so for the last eight years, is so very small. I find, although I have a gas engine and accumulators and have over 70 lamps, I am not paying more for gas than when I had gas burners.

I have taken all the companies in London, and have tabulated the revenue derived by each company per lamp per annum, taking the 33-watt electric lamp and the 10-candle gas burner. The Metropolitan Electric Supply Company derive a revenue of 12*s.* per lamp; the Chelsea Electric Supply Company, 8*s.* 6*d.* per annum; the Kensington and Knightsbridge, 9*s.* 2*d.*; the House-to-House Electric Supply Company, 11*s.* 6*d.* per annum; the St. James's and Pall Mall Electric Supply Company, 9*s.* 6*d.*; and a company, not in London, but in Brighton, obtains 8*s.* 6*d.*; the mean for 200,000 lamps being 10*s.*

I have also verified myself this ratio between the two. In the

General Post-office, where we burn a great quantity of gas, and where night operations are extended to late hours, and begin at early hours in the morning, there, from the experience of two years' working and comparison, we find that gas costs 18*s.* per lamp, and electricity 22*s.*, so the ratio there is one of 9 to 11, and not of 9 to 10.

Take the case of Manchester, where gas is cheaper than in most other towns. The average price paid per lamp for gas in Manchester is 7*s.* 6*d.* per annum, while taking the cost of electricity to the consumer at 5*d.*, the revenue that Manchester will derive from electric lamps will be 8*s.* 4*d.*

Of course the rates of charge vary very much. In London some private companies are charging 7½*d.*, and others 8*d.* In Bradford they commenced by charging 5*d.*, which they have since raised to 6*d.* In Newcastle they are charging 4½*d.* to the public, and they are allowing a large discount on that price to the large users of electricity. We in the Post-office are large users, and we have a discount of 20 per cent. off that 4½*d.*, which makes the cost of our electric lighting in Newcastle very nearly approach that of gas.

In factories where they have isolated installations, all facts show that electricity is cheaper than gas. I have figures from Bolton—from Messrs. Horrocks, Crewdson, & Co.—who are very large employers of labour in the district. They have had the electric light going for six years, and while they were using gas the cost per burner per annum came out at 5*s.* 6¾*d.* Since they generated their own electricity it comes out that their lamps cost 4*s.* 0¼*d.*, so there is a considerable reduction.

Those who know Manchester know that under the Exchange there is a large restaurant, which used to be unbearably hot when lighted with gas. The manager two years ago replaced gas by electricity, and he finds he is not only saving in cost of illumination, but has probably doubled his income by allowing his guests to have their meals in comfort.

So far as figures go, I have given you hard facts to show there is not much difference between the cost of electricity and that of gas. I tell all my friends that my house is lighted by gas, but I burn my gas in the garden, and allow all the vitiated gases to dissipate in the air, while I extract from the gas what I want—light, and have it in the house free from all impurities. If you take 25 cubic feet of gas and burn it direct, you will have only

50 candles of light with 10-candle burners, whereas if you burn your 25 cubic feet of gas in a gas engine, and convert it into electrical energy, it will give you 160 candle-power in the house. So, with a little care, you will be able to use the same gas and treble the amount of light in the house.

I see by the programme you are going to the Royal Naval Exhibition. The Royal Naval Exhibition is lighted by electricity. There is an engine-room fitted up there with the latest developments of electrical machinery, for electrical machinery is constantly changing; we are daily producing improvements of some kind or other. The electrical room is well worth your visiting, and you will see there how the electrical energy is generated, and you will probably find that one dynamo and one engine are supplying the electric current to the whole of the exhibition.

On Saturday you are going to have an even more interesting visit to the works of the Electric Supply Corporation, at Deptford. They are not completed, but there you will see preparations that are being made for lighting 1,000,000 lamps in London. At the present moment there is only sufficient machinery to light 200,000 lamps. You will be able to see there the space required for electrical machinery to light a million lamps. One of the great merits of electrical machinery over gas machinery is the small space which it uses. Gas requires 100 feet by 50 feet for every million cubic feet per annum; 100 feet by 50 feet is quite sufficient with electricity to light up one of our big towns.

We must not neglect other points. We must not neglect the fact that when we deal with electric lighting we are removing from our midst a source of deterioration to our goods, chattles, and pictures; we are removing something which destroys our decorations, and dirts our ceilings; we are introducing into our houses something which encourages cleanliness; we add materially to our comfort, and by adding to our comfort we add very much to our cheerfulness. I know nothing which adds so much to the cheerfulness of our lives as the electric light. I feel it will even add to our lives. I feel that if I had not had the electric light in my house for the last eight years I should not have been addressing you to-day; and I hope when you meet in London ten years hence I shall be able to come and address a larger body (for you will then be electrical engineers also), and give you experience of the progress and improvements which have been made.

Another point is, that it adds so much to the security of our

buildings and of our houses. It is not absolutely safe; it would be absurd to say it was. Carelessness and folly will cause fire by electric current as by gas. It requires supervision and the usual care that engineers know so well how to exercise.

But it is this question of health which I want to thrust down everybody's throat as the great merit of electric lighting, even if the price were very great indeed. We find in the Savings-bank Department of the General Post-office the cost of the electric light is actually paid for by the increased service we get out of our staff. The electric light has diminished the hours of sick absence two hours per head per annum. That put down at 10*d.* per hour, which is the lowest overtime rate in the Government service for clerks, means we save 680*l.* per annum. Our electric light costs us 700*l.* per annum, but after taking credit for this saving it is really costing us only 20*l.* a year. In the General Post-office itself we succeeded in putting in the electric light just before Christmas, and the Chief Controller told me the electric light enabled them to do their work quicker than ever before, and that the light was equal to 200 men.

The purity of the air you breathe, the sanitary aspect of the electric light, is the point and aspect which commends it so much to municipal engineers and local authorities. We must not forget that gas, when let into the air, has impurities which are poisonous. Gas burnt in a bedchamber is as bad as bad water and bad smells. The chief duties of municipal engineers have been to improve sanitary matters, to remove vegetable and decaying matter from water, and by a proper system of drainage to remove all dangers from health. But the duties of a municipal engineer will not be complete until he takes in hand the electric light.

There is another point I wish to urge—that is, that the electric lamp is not the lamp of luxury. The common argument is that it is a luxury only, and that it is only the rich man who can afford to pay for it. I say the electric light is the poor man's light. If you can have the light for 8*s.* 4*d.* per annum, the benefit which a working man derives from living in a pure atmosphere, instead of in close, unhealthy, ill-ventilated rooms, makes it worth the serious consideration of our local authorities. The price of gas is going up; the price of electricity is coming down. The price of gas is going up from labour disputes and strikes; the price of electricity is coming down because we know so very much more about it.

I have not said much yet about the relative cost of production of gas and the electric light. We can produce 1000 feet of gas for 1*s*. 10*d*.; the extra 2*d*. is for management and collection, though I have no doubt under certain conditions gas engineers can produce it for 1*s*. 7*d*., or 1*s*. 4*d*., or even 1*s*. What can we produce electricity for?

It so happens I have just been making exhaustive inquiries as to the cost of electricity in the production of phosphorus and copper. These are two industries where the use of the current is uniform and continuous, and the engines, dynamos, and everything working at their maximum efficiency. In electric lighting the use of the light is irregular. People will not go to bed at the same hour, or rise at the same hour, or all use the light together, so that the "load line" is variable. Where the load line is constant—and in works where copper and phosphorus is produced it is constant—you can produce your electricity for one-third of a penny per unit. There is no mistake about that figure—the cost of production of a unit of electricity on a large scale, with a constant load, is one-third of a penny. What does that mean? If we take the theoretical difference between gas and electricity, it is equal to gas produced at 3*d*. per 1000 feet. When we have the prospect of producing electricity at one-third of a penny per unit, equivalent to gas at 3*d*. per thousand, it shows that a vast field of development is before us.

There is one reason why gas is still ahead of electricity. It is that there is such a market in this country for residuals: the price obtained for coke and ammoniacal liquor and the other productions of gasworks, practically reduces the price of coal to the gas manufacturer in London to 4*s*. 6*d*. per ton. We have to pay in London for Welsh coal 23*s*. per ton. That is why we have to pay more for electric light than for gas. When we come to Gibraltar and Malta, where I recently went to see whether it was possible to introduce the electric light, there is no market for residuals, and it required no difficulty on my part to show that it was possible to produce electricity cheaper than gas.

I have endeavoured to the best of my ability to bring this matter before you as practical men, and I want you, if you agree with my conclusions, to point out to your different Boards that the duty of a Corporation is to look into this matter, not only from a financial, but from a political as well as a sanitary point of view, and, above all, from a philanthropic point of view, and to endeavour

to persuade them, as I have endeavoured to persuade you, that the electric light is the light of the future, and not the light of luxury merely, but the poor man's lamp as well.

## DISCUSSION.

Mr. J. Lemon: I have much pleasure in seconding the vote of thanks to Mr. Preece. I think he has given us most valuable information, and I would say to every gentleman (as I shall do to the best of my ability) try and educate your Boards throughout the country. Because if there is one question upon which there is ignorance, it is that of electric lighting. I tried my hardest some years ago to get my Corporation to take the electric light, and entirely failed. They said, "Why should we tax the ratepayers to provide a light for the rich." There is nothing more regrettable in my public career than my failure to introduce the electric light. If Corporations were to adopt the electric light, what has been foreshadowed by Mr. Preece will come to pass. But there is a prevailing feeling that the electric light is the light of luxury, and Corporations will consequently have nothing to do with it. When it can be shown that it is the poor man's light, as Mr. Preece has proved, I think the views of Local Boards and Corporations will change, and if it is shown that it is a light which can be supplied for 8*s.* 4*d.* per lamp per annum, I think all objections to the light, as a light of luxury, will vanish. I feel we are very much indebted to Mr. Preece for the extraordinarily clear and lucid address he has delivered.

Mr. Brodie: Mr. Preece alludes to the lighting of his own house, and he says the cost of lighting by electricity is the same, or very nearly the same, as lighting by gas. I should like to ask Mr. Preece whether, in comparing the cost of the two lights in his own house, he puts one gas bill against the other, or debits himself with the cost of gas engine, dynamo and plant. Because if he makes a present to himself of these things, the comparison is not quite a fair one. I also notice that Mr. Preece has taken the cost of electricity at Newcastle for his comparison; and there it is only 4½*d.* per unit with a large discount. This is an unfortunate instance to take, as coal should certainly be cheaper there than anywhere else. What I should like to know is

what would be the cost per unit at Malta and Gibraltar upon which Mr. Preece says he has reported, where the cost of coal is greater.

Mr. Fowler: I presume the cost is taken at the standard price of ordinary coal gas to work the dynamos, but if you introduce Dowson's gas you will reduce the cost of working the dynamo to about one-third. Dowson's gas with an anthracite coal costs only 2½*d.* or 3*d.* per thousand feet. If Dowson's gas can be made as cheaply as they represent, its use will reduce the cost of electricity very much. I am now going into the question of Dowson's gas for some large works I have in hand, where I intend to use it for working the engines, and it is deeply interesting to me from that point of view.

The President: Gentlemen, we have listened to a very interesting address from, I was going to say a great electrician, but with Mr. Preece's permission I will alter that term and say from a great sanitary engineer. You have just heard of the sanitary and many other advantages of electric light. I wish we had an opportunity of looking more closely into the figures before we had heard the address; as without some consideration it is difficult to draw conclusions from them, although they have been very concisely put before us by Mr. Preece. Great strides have been made in electric lighting within the last few years. I was interested in one of the first electric installations in London, the experiments at Holborn Viaduct, and comparing what can now be done with what could be done at that time, when a separate wire had to be carried from the engine to each lamp, when there was no means of breaking the current and producing a number of lights as we can now, we can realise the advance which has been made. The arc lamp is undoubtedly the cheapest form in which we can have electric light for street illumination, and when we hear that the cost of gas is going up and electricity is coming down in price, we must look forward to the time when electricity will replace gas very largely, if not altogether. As sanitary engineers it behoves us to encourage electricity; we shall then get rid of overheated rooms in workshops and factories. Mr. Preece felt tempted to invite us to visit the General Post-office and see the very interesting experiments they are making there in electric lighting. It so happens that we are obliged to withdraw one of these papers by reason of the illness of the author, and we might perhaps be able to find time this morning to visit the Post-office.

Mr. PREECE expressed regret that he had not made arrangements for such a visit.

The PRESIDENT: I can only say we have missed a very great treat in not seeing the works at the General Post-office. I have had the privilege of going over the works there, and I can assure you that you would have seen there something which you would not readily forget. I will now ask you to accord to Mr. Preece a most hearty vote of thanks for the honour he has done us in coming here to give us this most interesting and useful address.

Professor ROBINSON: I only wish to endorse what has been so well said in appreciation of the admirable address delivered by Mr. Preece.

The vote of thanks having been passed with acclamation,

Mr. PREECE, in reply, said: I am very grateful, Sir, to you for the kind way you have spoken, and to the members for the very warm and pleasing reception they have given me and my remarks. There are two or three questions which have been asked, and to which I will at once reply. The first is by Mr. Brodie as to the relative cost of electricity and gas in my house. I will cry *peccavi*. I only compared the price of gas before the electric light, with the price of gas paid now. I am using exactly the same quantity of gas in my engine as I did previously for lighting direct with gas; but by means of the engine I obtain three times the amount of light. It is not the first time the question has been put to me, "You, a business man allow nothing for depreciation nor for interest on capital." I say, "Certainly not. If you put aside for depreciation on your piano, or interest on the money paid for your pictures and furniture, then I shall be prepared to allow depreciation on my engines and dynamo." People do not do this; they spend their money freely on organs, on pictures, and on decorating their houses. It has been done out of revenue and lost sight of, and the 1000*l.* I have spent in my house in experimenting and in introducing every kind of novelty is gone, and I allow nothing for depreciation and nothing for capital. Then Mr. Brodie asks me whether I have taken into consideration the relative cost of coal in London and in Gibraltar and Malta. I have. The element of coal is not a very serious item in the cost of production of electric light; labour is more serious. The cost of coal in London is about 1*d.* per unit, that is, taking it at the rate of 4*d.* per unit, but as a matter of fact the cost of coal per unit in the General Post Office is ½*d.*, and that with best Welsh steam coal at 23*s.* per ton. Now you can get coal at Malta

and Gibraltar at 24*s.* and 25*s.* per ton; so really there is no perceptible difference as to coal in producing electricity in London and in Gibraltar and Malta. As to Dowson's gas, there is no doubt you can produce electrical energy by means of Dowson's gas in gas-engines at one-third the price of illuminating gas. The most careful experiments have been made by Messrs. Crossley's, at Manchester, and they prove by irrefragable figures that you can produce by means of Dowsons' gas a horse-power per hour for the equivalent of 1¼ lbs. of coal. The ordinary allowance is 2½ lbs. per horse-power. This shows only about one-half, but practically you can produce it by Dowson's gas at one-third the cost of ordinary gas.

# ELECTRIC LIGHTING BY MUNICIPAL AUTHORITIES.

By Professor HENRY ROBINSON, M. Inst. C.E., M. Inst. E.E.

As this is the first occasion on which I have met this Association since the Council paid me the compliment of electing me an Honorary Member, I desire to express my high appreciation of the honour conferred on me thereby. I gladly accede to the wish expressed to me that I should bring before this meeting the subject of Electric Lighting, especially from a Municipal point of view. The supply of electricity to the community may be now regarded as one of the requirements of the day, and it is of first importance to municipal authorities to consider the expediency of preserving the supply in their own hands. Many have lost the opportunity, and have allowed companies to obtain powers over their areas. Many are now deliberating upon the point, or are in conflict with companies; and, as I think, the question is ripe for decision, and I hold that it is not so advantageous for these undertakings to be carried out by private enterprise and by outside capital as it is by capital raised on the rates, whether from a financial or public point.

When Mr. Chamberlain, as President of the Board of Trade, in 1882, was engaged in the lengthened inquiry on the subject of electric lighting (which resulted in the Act of that year), an organisation composed chiefly of delegates of the principal municipal corporations urged upon the Board of Trade the necessity for entrusting the supply of electricity to local authorities, in preference to companies, in order to avoid the creation of another monopoly like gas and water, and to ensure the profits of the undertaking being secured to the ratepayers instead of to outside companies. A prominent part was taken in the action at that time by Mr. T. Eccleston Gibb (the Vestry Clerk of St. Pancras), whose judgment and experience in affairs relating to municipal government is

probably second to none in the kingdom. He held the strong opinion that the authority should keep the powers in their own hands, and Dr. Hopkinson, F.R.S., and myself were consulted at that time with a view to this policy being pursued in the St. Pancras district. The result was that a Provisional Order was obtained in 1883, by which all the companies were and have been ever since excluded from this district, and in this respect St. Pancras has been an exception to the rest of the metropolis in having acquired these powers. The onerous conditions imposed on companies by the Act of 1882, together with the failure of the most prominent companies to realise the anticipations that had been held out by them, led to a period of suspense which was beneficial, inasmuch as during that interval many technical and practical difficulties were overcome as regards the production and supply of electrical energy. In the year 1888 an Amending Act was passed, under which many of the onerous conditions were removed, and by which the monopoly acquired by any company was extended to forty-two years. By this time numerous able and enterprising inventors had been devoting themselves to perfecting the machinery for producing the supply of electricity, and of the methods of distributing it. During these years the Patent Office presents a record of inventions probably unique in the history of that department, and whatever opinion may be held as to who should undertake the work, the thanks of the community are undoubtedly due to those who served as pioneers. The time had then arrived when (as I stated to the St. Pancras Vestry in March 1889) a public body need no longer hesitate to engage in the business, and from the points of view of finance and general convenience it was most desirable for the business to be undertaken by the authority. As regards finance, the authority can provide the necessary capital at a far lower rate than a company can, and as regards convenience, the public lighting of the streets, the disturbance of roads, and the sanitary advantages of substituting electric light for gas in dwellings, point to their being matters that clearly devolve on the authority to deal with. The wide field that is open for the employment of electrical energy for motive power, tractive, and public lighting purposes, is also a further reason for the supply being in the hands of the authority.

I think it will be useful to put on record in your 'Proceedings' calculations that I have made of the relative cost of gas and electricity which have appeared in various reports of mine, when advising on the subject of electric lighting.

TABLE SHOWING COST OF GAS LIGHTING.

| Description of Burner. | Candle Power. | Consumption of Gas per hour per Lamp. | Candle Power per cubic foot used per hour. | Cost per hour with Gas at 2*s.* 9*d.* per 1000 cubic feet. | |
|---|---|---|---|---|---|
| | | | | Per Lamp. | Per Candle Power. |
| | | Cub. ft. | | Pence. | Pence. |
| Ordinary Batswing .. | 10 | 4·3 | 2¼ | ·142 | ·0142 |
| Flat Frame from | 11·5 | 4·6 | 2½ | ·152 | ·0132 |
| Flat Frame to | 13·8 | 4·6 | 3 | ·152 | ·0110 |
| Flat Flames in Clusters | 60 | 15 | 4 | ·495 | ·0083 |
| | 90 | 20 | 4½ | ·66 | ·0073 |
| | 150 | 30 | 5 | ·99 | ·0066 |
| Special form (requiring motive power) | 120 | 10 | 12 | ·33 | ·0028 |

On an average it may be assumed that each private lamp in London will be used for 1½ to 2 hours per day throughout the year, whilst in the suburbs it will be used 1 to 1½ hour per day. In shops open till 9 o'clock, each lamp will be used 3 hours per day, and for public-houses, restaurants, &c., each lamp will be used 4 to 5 hours per day throughout the year.

The annual cost of gas would thus be in a private house with 30 lights used on an average 1½ hour a day, or 547 hours per annum:—

| | £ | *s.* | *d.* |
|---|---|---|---|
| 547 × 30 = 16,410 lamp hours at ·152*d.* .. .. .. | 10 | 7 | 11 |
| Add for rent of meter .. .. .. .. .. .. .. .. .. | 0 | 14 | 0 |
| Annual cost .. .. .. .. .. .. | £11 | 1 | 11 |

The cost of gas-piping and ordinary (not ornamental) fittings may be taken as follows:—

| | |
|---|---|
| Workshops and Factories .. .. .. .. | 20*s.* to 25*s.* per light. |
| Shops .. .. .. .. .. .. .. .. .. .. | 25*s.* to 35*s.* ,, |
| Private Houses (with 20 to 40 lights) .. | 30*s.* to 40*s.* ,, |

It has been feared that gas properties will be injuriously affected by the general introduction of electric lighting, and that feeling has influenced some municipal authorities who own the gasworks either to oppose electric lighting orders or to secure them with a view to their not being acted on. I think the apprehension of gas properties being injured is exaggerated. There is an increasing

demand for gas for warming, for cooking, for motive power, and for other purposes, which makes it quite possible that the consumption of gas in the future may not be so diminished as is feared.

I will next give the result of my calculations and experience as to the cost of electricity. In a private house with 30 lights used on an average 1½ hours a day, or 547 hours per annum, the total lamp hours will be 16,410 per annum, as before.

In order to compare with the estimate for gas previously given, a 12½ candle-power may be taken as the average for each lamp (some being 10 and others 16 c.p.).

The actual cost of producing a Board of Trade unit of electricity may be taken at about 2½*d.*, excluding the provision for the sinking fund, or 3½*d.* per unit including that provision. At the rate of 3½*d.* per unit, the cost would be as follows:—

$\cdot 0135 \times 12\frac{1}{2} = \cdot 169d.$ per lamp hour, including renewals.

| | £ | s. | d. |
|---|---|---|---|
| 16,410 lamp hours at ·169*d.* .. .. .. .. .. .. | 11 | 11 | 1 |
| Add for rent of meter .. .. .. .. .. .. .. .. | 0 | 14 | 0 |
| Total .. .. .. .. .. .. | £12 | 5 | 1 |

If the current is charged at 6*d.* per unit (which is lower than most companies charge, and will yield a profit to the authority) the cost per candle-power per hour will be about ·022*d.* per lamp hour, or 0·275*d.* including renewals, in which latter case the cost of the 12 c.p. lamp would be 19*l.* 10*s.* per annum, instead of 12*l.* 5*s.* 1*d.*

For workshops and factories the cost of ordinary fittings for electric light will be from 25*s.* to 30*s.* per lamp.

| | |
|---|---|
| Shops .. .. .. .. .. .. .. .. | 30*s.* to 40*s.* per lamp. |
| Private Houses (with 20 to 40 lights) .. | 35*s.* to 45*s.* „ |

There are several advantages in employing electricity instead of gas to which it is difficult to assign a money value. For instance, the whitewashing, painting, and papering of rooms would be seldom necessary when electric lighting is employed. The vitiation of the air by gas would be obviated, with good sanitary results, and the risks of fire would be diminished. In comparing the respective cost of gas and electricity the lamp hours are calculated as the same in both, whereas I think it will be found to be less with electric lights, as a light or series of lights are switched on and off so easily that it is found the light is more frequently turned off when it is not wanted than is the case with gas. Where delicate

textile fabrics and decorative or artistic goods are exposed, it is found that the substitution of electric light for gas is attended with great advantage as regards their preservation, and also in enabling colours to be matched. Electric light is preferred to gas, where wines, beer, &c., are stored, as it preserves the cellars and vaults cool.

I will next deal with public lighting, which concerns municipal authorities very closely.

For street lighting the arc lamp is the most economical. The smallest size of arc lamp at present manufactured requires a current of about 5 amperes, but for steadiness and efficiency it is desirable not to use less than 6 amperes. The candle-power of arc lamps varies considerably, according to the angle at which it is measured. The greatest intensity with continuous current lamps is found at an angle of about 40 degrees below the horizontal line. The following Table gives the approximate candle-power at various angles. The height of the lamps should be arranged so as to give an angle of not less than 7 degrees to the most distant point which it is intended to serve.

### Lighting Power of Arc Lamps.

| Current in Amperes. | Candle Power. | | | | |
|---|---|---|---|---|---|
| | Horizontal. | At angle of 7 degrees. | At angle of 10 degrees. | At angle of 20 degrees. | Maximum at angle of 40 degrees. |
| 6 | 92 | 175 | 207 | 322 | 460 |
| 8 | 156 | 300 | 350 | 546 | 780 |
| 10 | 220 | 420 | 495 | 770 | 1100 |

The following Table gives the cost of working arc lamps:—

| Current in Amperes. | Average Candle Power at angle of 20 degrees. | Watts required. | Units used per hour. | Cost of Current at 3½d. per unit. | Cost of Carbons ·50 and Fixing ·16. | Total cost per Lamp Hour. | Cost per average Candle Power per hour. |
|---|---|---|---|---|---|---|---|
| | | | | Pence. | Pence. | Pence. | Pence. |
| 6 | 322 | 300 | 0·3 | 1·05 | 0·66 | 1·71 | ·00531 |
| 8 | 546 | 400 | 0·4 | 1·40 | 0·66 | 2·06 | ·00377 |
| 10 | 770 | 500 | 0·5 | 1·75 | 0·66 | 4·21 | ·00313 |

The last column in the table gives the cost per candle-power per hour, and these figures are arrived at by dividing the "total cost per lamp hour" by the figures representing candle powers "at an angle of 20 degrees" (given in the table of lighting power) which represents a fair average of the power from arc lamps. The last column in the table of cost admits of comparison with the last column of the table previously given of the cost of gas.

Arc lights should be placed high up for the following reasons:—

1st. On account of their high candle-power and great distance apart.
2nd. Because the light thrown down at an angle is much greater than that cast horizontally.
3rd. Because the light given horizontally is not so steady as that which is thrown down at an angle.

The following data enable the coefficient of minimum lighting power in streets to be determined:—

Let P = candle power of lamps.
L = maximum distance from lamp in feet.
H = height of lamp in feet.
X = a coefficient.

The light falling on a unit area of pavement varies inversely as the square of the distance from the lamp, and is directly proportional to the angle at which it falls. This angle is nearly proportional to the height of the lamp divided by the distance. Therefore—

$$X = \frac{P}{L^2} \times \frac{H}{L}$$

or

$$X = \frac{PH}{L^3}.$$

The usual standard of gas lighting is represented by the amount of light falling on a unit area of pavement 50 feet away from a 12 candle-power gas lamp 9 feet high, which gives a coefficient as follows:—

$$X = \frac{12 \times 9}{50^3} = \cdot000864.$$

Adopting the above coefficient, I calculate that the before-

mentioned sizes of arc lights will give the same standard of light at the heights and distances stated in Table A.

TABLE A.

| Current in Amperes. | Height of Lamps. | | | |
|---|---|---|---|---|
| | 20 feet. | 25 feet. | 30 feet. | 35 feet. |
| | Maximum Distances served from Lamp in feet. | | | |
| 6 | 160 | 175 | 190 | 202 |
| 8 | 185 | 202 | 220 | 235 |
| 10 | 205 | 225 | 243 | 260 |

Table B gives the corresponding distances, assuming the minimum standard to be doubled, thus bringing the coefficient up to ·001728, which represents the amount of light on a unit area 50 feet away from a 24 c.p. lamp 9 feet high.

TABLE B.

| Current in Amperes. | Height of Lamps. | | | |
|---|---|---|---|---|
| | 20 feet. | 25 feet. | 30 feet. | 35 feet. |
| 6 | 130 | 144 | 155 | 166 |
| 8 | 150 | 165 | 180 | 193 |
| 10 | 170 | 190 | 205 | 220 |

The distances the lamps are apart would of course be double the distances mentioned in Tables A and B.

One arc lamp will take the place of from 3 to 6 gas lamps, according to the locality, arrangement, and standard of light adopted.

A scheme of arc lighting, based on the substitution of one arc light on the average for 3½ to 4 gas lamps, would double the minimum standard of light, whilst the average standard would be increased 10 or 12 times.

Placing lamps along the middle of the streets has the advantage of illuminating the fronts of the houses more uniformly, and this advantage is more apparent when the lamps are of higher candle power than that of the present gas lamps. Moreover in business thoroughfares the footways are often fairly illuminated by the shoplights, whereas the middle of the road is thrown more into shadow.

The regulation of traffic in crowded thoroughfares would be much assisted by a well-considered system of large lights and shelters or refuges, and the cost of police control over traffic in streets likely to become congested would be reduced thereby, whilst the number of accidents would diminish.

A higher standard of street lighting appears to be inevitable in the near future, even if it is attended with increased cost. This is evidenced by the fact that authorities are now directing their attention to affording a much larger amount of light in main thoroughfares than has heretofore been accepted as sufficient.

In carrying out a system of public lighting by electricity, the fact that the lights can be instantaneously switched on and off at a central station may be taken into account. By having a second main and by connecting the lamps alternately to the two mains, every alternate light could be switched off at say midnight, and a saving effected in the annual cost. It should be noticed that with public gas lamps an appreciable time is taken up in the operation of lighting and extinguishing, by which the lamps that are first lighted and last extinguished have been consuming gas beyond the actual time that is needed for lighting purposes. A series of electric lights, on the other hand, admit of being switched on and off at the central station at the exact time required by the season, so that practically the number of lamp hours in the case of electric lights is less than with gas lights to the extent of several hundred lamp hours per annum.

It is not within the province of this paper to refer to the various methods for generating and distributing electricity. Municipal authorities have abundant practical data to enable them to be advised as to the introduction of the right system for electric supply in a district. This requires good judgment and a careful consideration of present requirements, having in view the possibility of future developments.

## DISCUSSION.

Mr. C. Jones: I rise to propose a vote of thanks to our friend Professor Robinson, for the exceedingly interesting paper he has given us. It is not my intention to discuss it in any way. It is not a subject I am well at home with, although I have given some amount of attention to it. Upon this matter we have not arrived at a stage at which we can criticise the work of experts. There is

no doubt about one thing, we shall sooner or later have to give attention to this very important question of street lighting. Although I know the views I hold are not in accordance with some which have been expressed at our meetings, I think it will become the duty and pleasure of every Municipal Officer to consider as to the advisability of adopting this or that system, and to advise his Municipality upon the several schemes put forth. Therefore it is a matter of great benefit that we should have papers prepared by experts and submitted to this meeting. There are one or two points in the paper to which I should like to refer. Experiments as to the best form of street lighting have been carried on in the city and culminated in Queen Victoria Street last night. I think Mr. Preece was away from our dinner on that very account, in order that he might witness these important installations, and I think it not impossible that many of us will find our way to Queen Victoria Street at 9 or 10 o'clock to night, to see what can be done in electric lighting by a Municipality whose purse is a very long one, and who are doing what you and I cannot do in our own small places. I mention this so that members may go and see the class of lamp standard which is being fixed there. We obtained a Provisional Order only last week for Ealing, which enables us to spend some 30,000*l.*; therefore I do feel some interest in this question of electric lighting. I notice that the Professor refers to the possiblities of switching off a portion of the lights at a certain hour. Now all those who are used to driving will know that when you are driving in the dark and happen to meet a carriage with very bright lights, the horses are startled, and that suggests a difficulty of switching off a number of the lamps, as portions of the thoroughfares would be very light and other portions very dark. As to placing lamps along the middle of the roads, Tottenham Court Road would be a very advisable place to make such an experiment, but Professor Robinson must remember that there is only one Tottenham Court Road in London. I have been in Paris where the lamps are fixed in the same way, but then the roadways are 60 feet wide, so there is a great wide thoroughfare on each side of the electric lamp. Personally I thank you very much for the interesting paper you have read, following Mr. Preece's paper, which corroborates it. I hope we shall bear in mind the lessons we are learning to-day and put them to a profitable use.

Mr. E. Pritchard: I have much pleasure in seconding the vote of thanks to Professor Robinson for his paper. As Mr. Jones

has remarked, it follows very properly the address we have heard from Mr. Preece. There are two or three points to which I should like to draw attention, more particularly as now, for twelve months, I have had some practical experience upon a work with which I have been professionally connected in connection with the generation of electricity for power traction and lighting. It will not perhaps be out of place if I offer some remarks thereon. Professor Robinson points out the full value of electricity not only for lighting, but also as a motor for the purpose of traction. I grant that for traction purposes, other than by storage batteries, much depends upon the action of the Board of Trade. This last week I have been engaged in two Bills before Parliament where a severe reverse has been given to electric traction in this country. In the case of electric traction it can only be used to its best advantage where the earth is used for the return current. In America, for every purpose of electric traction where the voltage does not exceed 300, the earth has been the common return. We have already been working upon that principle in England to a small extent, and are now proposing to do so to a greater extent. This principle of earth returns has for years been adopted with our telegraphs and more recently with telephones, with the result that the magnetic influence of the earth caused by the various gas and water mains and other metallic substances has by induction rendered the telephones at various times to act in a most erratic manner, making signalling and speaking at certain times most ineffective. The Postmaster-General has in most tramway orders, where electric power is sought, got a clause inserted that there shall be no interference with the working of the telegraphs in connection with the Post-office. The telephone companies have not had such a clause. They say "We were here before you, and you have no need of it. We have the earth, it is our natural return; you shall not have it." And the National Telephone Company now seek to compel tramway companies to use a metallic return with electric traction. Unfortunately the Committee of the House of Lords, presided over by his Grace the Duke of Westminster, last week insisted that the telephone companies shall be protected. Where the earth is commonly used for the return of electrical tram traction currents, the telephones, if they are to be useful, must have a metallic return, and the leads be properly protected. The telephone companies ought to have done this in the first instance, so that the subscribers should not be troubled with the noise,

buzzing and confusion, and also hearing what people are saying which it is not intended they should hear. It means instead of having an earth return for traction that we must now have a metallic return; and as we are not likely to be permitted to work upon the overhead system as in America, it will be necessary to adopt the expensive conduit system. The extra cost to the companies will be 1500*l.* per single mile of two rails if on the conduit system, whilst with an overhead system and underground return the cost will be from 3000*l.* to 4000*l.* a mile of two rails. It must be obvious that electric traction has been seriously hampered by the decision of the Lords' Committee referred to in the two important cases of the Birmingham Central tramways and the Bristol tramways. I agree with Professor Robinson as to the use of gas engines, and as to gas still continuing to pay the dividends it does pay. There can be no two opinions of the desirability, particularly from the sanitary points of view, of having the electric light substituted for the gaslight in the present objectionable form in our houses. In reference to the cost of the engines, although Professor Robinson has given us the cost of installations and fittings he has not given us what I am sure will be very valuable information (and I am sure he has made calculations) as to the cost of lighting for isolated houses.

Professor Robinson: It includes the capital outlay.

Mr. Pritchard: I am pleased to hear that, because much will depend upon the number of lights. If we have 50 lights in our houses it is necessary to put down a gas engine, dynamo, and, I presume, accumulators.

Professor Robinson: I am dealing with an installation of say 8000 or 10,000 lights simultaneously at work. It would not apply to a very small installation.

Mr. Pritchard: With gas engines we can generate with Dowson's gas at a very moderate cost indeed. I have put down something like 300 horse-power gas engines in the country for pumping purposes, and I can corroborate what has fallen from Mr. Fowler and Mr. Preece as to the economical working of Dowson's gas; if properly attended to I find 1½ lb. of coke is sufficient to give an indicated horse-power per hour. If you are working a gas engine to the greatest advantage it is necessary to have it running at its effective or maximum power, because there is considerable friction in the engine itself which cannot be ignored. I should like Professor Robinson, with reference to the tables on page 241, to

say the voltage which he considers desirable for electric lighting, and whether in that case there is any danger in having a higher electric motive power or any advantage to be gained in having less than he has adopted. In South Africa, where coals are dear, I found from personal observations in Kimberley and Johannesburg, and also in America, grand examples of lighting streets by the arc lamp, and I can quite corroborate as to the splendid effect produced by strong electric light arc lamps, chiefly in squares and wide streets, if placed sufficiently high; but where you come to narrow streets I do not think the electric light is so effective as the ordinary gas lighting.

Mr. Silcock: I should like, if you will allow me, to support this vote of thanks to Professor Robinson for the very interesting paper he has read, and I rise Sir, to speak with more especial pleasure because the figures and the conclusions which Professor Robinson has drawn, I believe coincide almost entirely with the views I expressed in a paper read before this Association at Portsmouth. The fact that Corporations should so far as possible keep the lighting in their own hands was one of the chief points I tried to make in that paper, and I believe it is to the interest of local authorities to keep all such public works as that under their own control. Turning to the figures which Professor Robinson has given us, and which Mr. Preece had previously given, they are practically the same figures as I gave two years ago. That 3*s.* 8*d.* which I see on the board there is practically the same figure, for I believe I stated in my paper the cost of gas at 3*s.* 9*d.* was about equivalent to ordinary incandescent lighting. There is this fact Mr. Preece overlooked, he did not allow anything for the renewal of lamps. He gives us the cost of lamps per annum not including the cost of renewals, which comes to about 50 per cent. more. That is a very high figure, but in the course of a few years you will be able to buy lamps for 6*d.* or 1*s.* and this cost will be very much reduced. The figures also agree with a recently published report of Mr. Crompton on the Glasgow lighting. I believe he said the cost of power from a central station at Glasgow if provided by the Municipal Authorities, and reckoning all charges, for a minimum output would be 7½*d.* per unit, taking an average output he put the cost at 4*d.* per unit, and with a maximum output it would come down as low as 2¼*d.* This report of which I am speaking is well worth looking into by the members of the Association, because it gives full figures and tables. The chief

point to which I should like to draw attention is the large proportion of the total cost which has to be put down to the capital and establishment charges, out of 7½*d.* the engine room expenses are under 1*d.*, and about one-half of the remainder is depreciation and repairs, and the other half is entirely capital and establishment charges. So that it appears the great point to which electrical engineers want to direct their attention is to produce the apparatus at a very much cheaper rate. We have got engines which leave nothing to be desired, and dynamos which are the most perfect machines used in practical engineering works, and we shall soon have lamps at a very cheap rate, which will reduce the cost of renewals, and then the chief point to be looked at is the reduction of capital cost. The table which Professor Robinson gives of the power of arc lamps at different angles is very useful, and when combined with his formula of calculating the lighting effect of lamps at different heights, is very interesting. I have never seen a formula dealing with this question before, but this appears to me to be absolutely correct instead of only approximately so as stated by the Professor. If the unit area is taken small enough the light on it would vary as the cosine of the angle between the perpendicular and the ray of light falling on the centre of the unit area, and inversely as the square of the distance, in other words we get $\frac{P}{L^2} \times \frac{H}{L}$ of the formula. Referring to the distance of arc lamps apart, I remember I suggested that about 80 yards radius would be about what an ordinary arc would be capable of lighting. If you have the lamps on the side of the streets that 80 yards would have to be considerably reduced—probably one-third. Then as to the paragraph on the top of page 244, that is exemplified by what we saw in the City last night, and the effect of the lighting in Queen Victoria Street is very good indeed. The lamps there, however, are only about 40 yards apart and appear not to be sufficiently high.

The President: Our best thanks are due to our esteemed honorary member, Professor Robinson; and it gives me great pleasure, to put the resolution which was so well proposed by Mr. Jones, and seconded by Mr. Pritchard.

The resolution having been adopted with acclamation,

Professor Robinson: As regards the switching off a certain proportion of the public lamps, to which Mr. Jones has referred, I only threw it out as a suggestion that if the public lights in

some of the main thoroughfares were placed sufficiently close together, every alternate light might be switched off at a certain hour, leaving a minimum light equal to gas, and you have a very much better light than usual during the ordinary hours of the evening. For this you require an additional high tension cable at a cost of probably only 50*l.* a mile. As regards traction, I quite feel that the decision of the Duke of Westminster's Committee referred to by Mr. Pritchard will cause great embarrassment to those who relied upon the earth as the return current. In the St. Pancras district the question of electrical traction has not arisen, and the use of the current will be to enable motors to be worked for business purposes. But for traction purposes it opens out a very wide field which would alone take a morning for discussion. Since the St. Pancras Vestry have undertaken the duty of carrying out this installation, for which I am engineer, people are establishing themselves in the district for the purpose of using the electrical energy for commercial purposes. Works are being started, and there is evidently a great field for the use of electrical energy for manufacturing purposes. I do not deal with any question of the best methods of distributing the electrical energy. In the case I am concerned in now I have adopted the continuous low tension system of 110 volts for incandescent lighting and 540 to 575 volts high tension system for arc lighting. Those who are engaged in advising Authorities should be extremely careful what system they adopt. I had to decide at St. Pancras what system to adopt where the demand is within half a mile of a central station, and enough consumers to take, not only 10,000 lamps, but in a short time it will probably be 20,000 or 30,000 lamps. I therefore adopted the low tension continuous system, but where these conditions do not exist I should use the high tension transformer system. As regards the cost of production, perhaps the following extract from one of my reports may be of interest.

The cost of producing a unit of electricity depends upon the size of the installation and upon the number of hours the lamps are used per annum, and I have prepared a table to show this, in order that you may see clearly the advantage of commencing with an installation of 10,000 lights instead of one with 5000 lights. I have based my calculations upon the very liberal assumption that every additional 5000 lights (beyond 10,000) will cost the same as the second 5000 lights.

The first column gives the number of 16 candle-power incan-

descent lamps which the plant is capable of serving simultaneously The number of lamps which may be safely installed will be considerably more than these, as it has been found in practice that the maximum number in use at one time lies somewhere between two-thirds and three-fourths of the number of lamps installed.

The number of units sold per annum is taken at eighty times the number of lamps given in the first column for the first two cases, and then in diminishing proportion down to seventy times in the last case.

| Number of lamps of 16 candle-power. | Cost of producing one unit (excluding Sinking Fund). |
|---|---|
| 5,000 | 3·27 pence |
| 10,000 | 2·80 „ |
| 15,000 | 2·70 „ |
| 20,000 | 2·70 „ |
| 30,000 | 2·70 „ |

In calculating the above table I have taken non-condensing engines as being employed at the central station, which are less economical than condensing engines. The latter use about 25 per cent. less steam, saving therefore that percentage of coal and stoking, and this, with the reduction in depreciation of boilers, &c., represents about one farthing per unit. If condensing engines are employed, the above figures, therefore, would be reduced by about the twenty-fifth of a penny.

In conclusion, I desire to return my heartiest thanks to the council for the courtesy and kindness they have shown in making me an honorary member of this Association and to the members for the reception they have accorded to my paper.

## VISITS TO WORKS.

In the evening of Thursday the 25th the annual dinner of the Association was held in the Venetian Saloon of the Holborn Restaurant.

### 1. *Visit to Messrs. Doulton's Potteries at Lambeth.*

On the second day (Friday), after the discussion of the papers, the members took steamboat at Westminster Pier and proceeded to Messrs. Doulton's potteries at Lambeth, which they explored in several departments, paying special regard to sanitary appliances, although evincing much interest in the production of the now well-known Doulton art pottery. Here the visitors were entertained at luncheon by Sir Henry Doulton, who in the course of a speech gave some interesting reminiscences of the early days of sanitary pottery ware.

### 2. *Visit to Electric Railway Depot Works at Stockwell.*

The party left Messrs. Doulton's works in brakes for the Electric Railway Depot Works at Stockwell, where the mode of construction of the City and South London Railway was explained to the members by Mr. H. Greathead, the chief engineer of the company, who designed and constructed the railway. This method of construction, it was pointed out, has special interest on account of its suitability for driving tunnels for waterworks, for sewers in order to avoid interference with streets and to secure economy and speed, and for communications for general traffic. The largest tunnel hitherto constructed in this way is 20 feet in diameter, and the smallest about 8 feet and 9 feet in diameter, but larger and smaller tunnels are proposed. One great feature claimed for this method of construction is that the iron tunnels are made perfectly watertight, and another is that they can be driven with absolute safety through any material and under water without the necessity

of pumping the water out of the surrounding strata. There are six stations upon the line, which is worked by electricity generated at the depot. Each train at present consists of three carriages seating 100 passengers and an electric locomotive. These trains are now run at intervals of from five to six minutes, but it is intended to run them at shorter intervals as soon as the necessary additional rolling stock has been acquired.

Proceeding by the line to the City station in King William Street, the members took boat at Old Swan Pier for the Naval Exhibition, where they spent the evening.

### 3. *Visit to the Tower Bridge.*

On the third day (Saturday the 27th), the members embarked on board the *Shah* steamboat (kindly provided by the President) at the Temple Pier, and proceeded down the river, inspecting first of all the Tower Bridge. The total length of this bridge and abutments is 940 feet, and including the approaches, 2640 feet. The width of the opening span is 200 feet, giving a headway above high water when opened, of 139 feet 6 inches, and when shut, 29 feet 6 inches. The width of the side spans is 270 feet, giving a headway of from 20 to 27 feet above high water. The width between parapets in the opening span is 50 feet, and in the side spans and approaches 60 feet. The steepest gradient of the approaches is 1 in 40 (steepest gradient of the approaches of London Bridge 1 in 27). The depth of foundations is 60 feet below T.H.W., and 27 feet below the bed of the river. The sectional area of waterway is 20,040 square feet (that of London Bridge 19,300 square feet). The depth of water in the opening span at high water is 33 feet 6 inches, and at low water 13 feet 6 inches. Each leaf of the opening span is 50 feet wide by 100 feet long, and weighs, inclusive of roadway and counter-balance weights, 950 tons. The following are the estimated quantities of materials in the bridge and approaches—31,000,000 bricks, 70,500 cubic yards of concrete, 19,500 tons cement, 235,000 cubic feet of granite and other stone, and 15,000 tons of iron and steel. Of machinery, there are two steam pumping engines for hydraulic machinery, each 360 H.P., eight large hydraulic engines, and six accumulators and four hydraulic lifts in towers for passengers.

The estimated cost of the work is 750,000*l*. Mr. John Wolfe Barry is the engineer, and Mr. E. W. Cruttwell is the resident engineer. The last-named gentleman very kindly received the members and explained the construction of the bridge to them.

### 4. *Visit to Deptford Cattle Market.*

The members next proceeded to Deptford, where, by the courtesy of the London County Council, they were permitted to go over the extensive abattoirs.

The Deptford Cattle Market is erected on the site of the old Deptford Dockyard. It contains an area of about 30 acres, having a river frontage of nearly 1100 feet. It was constructed by the Corporation of London, and opened for public use in January, 1872. There is covered lairage for about 5000 cattle and 23,000 sheep. There are 70 slaughterhouses. The number of animals slaughtered daily varies considerably; weekly about 3000 bullocks, 500 calves, and 2300 sheep.

There is chill room capacity for treating 800 sides of beef per day. The chill rooms have been lately enlarged; the machinery, by Haslam, of Derby, is the largest in England, and is capable of passing 150,000 cubic feet of cold air per hour. Vessels of large (4500) tonnage are able to discharge at jetties, of which there are three, and the continental steamers can unload at any state of the tide. Peter the Great worked at the old dockyard that was here, and the remains of an old monastery may still be seen.

### 5. *Visit to the Works of the Electric Supply Corporation, Deptford.*

From Deptford Cattle Market the members walked to the works of the Electric Supply Corporation, which are of special interest as marking a new departure in electric light, the current being generated outside London and conveyed in mains to distributing stations.

Deptford central station is the generating station of Mr. Ferranti's system. Here the large currents are generated and transmitted to the four distributing stations in London, of which

the Grosvenor and Trafalgar only are at present in working order. The Pimlico and Blackfriars are in course of construction.

The great 10,000 H.P. dynamos are not yet completed, and probably months will elapse before they are ready.

The station is a large building of 210 feet by 195, the height of the main building 100 feet, and chimney shafts 150. The whole of the plant is made on the premises.

The two large dynamos are of 1500 H.P. and generate current at 10,000 volts. The diameter of each armature is 13 feet, and the height of the machine from the bed-plate 14 feet 6 inches. Each machine possesses 48 armature bobbins, which are copper strips wound on a core of insulated brass strips, and connected in pairs. New ones can be replaced on the armatures in a few minutes, a characteristic which is found in all the Ferranti dynamos. On the faces of the field magnets are fixed two ebonite caps fastened one inside the other with Ferranti compound. Each of these caps is tested to 20,000 volts, they thus prevent sparking from the armature to the frame of the machine.

By means of special machinery the field-magnet frames of the dynamo can be drawn back for cleaning in less than ten minutes. The exciting machines (Allen and Kapp dynamos) are placed at the rear of the large dynamos; they are of slow speed, 200 revolutions, 50 volts, and 400 amperes each. By means of special switches they can be connected to any of the dynamos, or run in parallel, amperemeters and voltmeters on each machine indicating the exact state of the exciter.

The engines driving the large dynamos are of 1500 H.P., and are of the vertical marine Corliss type, made by Hicks, Hargreaves, & Co., Bolton. The driving power is transmitted by forty 5-inch ropes on a flywheel of 22 feet diameter, weighing 60 tons. The stroke of the engines is 4 feet. The low-pressure cylinder measures 56 inches, the high-pressure measuring 28.

Although the corporation intended that the Grosvenor station was ultimately to be a distributing centre, current was generated there for some time. Owing, however, to the Courts issuing an injunction, the generating plant was stopped and removed to Deptford, and is driven by two new 700 H.P. engines. The two dynamos of 625 H.P. are of slow speed, and each gives a pressure of 2500 volts, which is converted by four 150 H.P. transformers

to 10,000 volts. A Siemens' exciter is used to each dynamo, a small Kapp exciter being available in case of accident.

The engines are fitted with Corliss valves, with high and low pressure cylinders built in tandem. The diameter of the flywheel weighing 35 tons, is 24 feet, 17 ropes driving the dynamos.

The switchboard is placed upon a specially insulated platform. Here the current from the four dynamos is brought and passes through amperemetres, and then, by a switch with a 3-feet break, on to the omnibus mains. Each of the 1500 horse-power dynamos is connected in the same fashion, so that all may be at once placed in parallel. A separate amperemeter on each London main indicates the amount of current passing through it. The resistances for regulating the voltage are placed between the foundations of the engines, and are worked by ebonite tubes running in slides. The fuses are placed in specially tempered glass, as the exact state of the fuse is seen.

The boiler house contains twenty-four 500 horse-power boilers. It is intended to place an additional twenty-four.

A novel and curious piece of plant is an armature ring of one of the 10,000 horse-power dynamos. It measures 35 feet in diameter; it is made of cast iron in eleven pieces, and is to be fastened to the dynamo shaft by cast iron arms or spokes, each of which will be in turn secured to the shaft by a double-milled steel ring shrunk on, whilst as an additional security twenty-two solid steel bolts, 6 inches diameter, each weighing when finished 12 cwt., passing through the outside of the armature ring, screw direct into a steel ring mounted round the centre of the dynamo shaft. The armature and shaft when completed will weigh 225 tons, and the field magnets 350 tons more. One 5000 horse-power engine is to be fixed at each end of the dynamo shaft; the armature thus being in the centre, and taking the place of the ordinary flywheel; the bobbin holders are fixed in the same way as on the 1250 machines, 132 coils being used. Five dynamos of this type, each supplying 200,000 lights, are to be built. It is stated that since February 10th the mains have been working most successfully at a daily pressure of 10,000 volts, as since that date the whole of the supply of current to the London Electric Supply Corporation has been transmitted at that pressure from Deptford to London.

### 6. *Visit to the South Metropolitan Sewage Outfall Works at Crossness.*

The members then walked to Greenwich Pier and again went on board the steamer, where they were entertained at luncheon by the President, while they were on their way to the South Metropolitan Sewage Outfall Works at Crossness. These works may be said to consist of the pumping station, erected by the late Sir Joseph Bazalgette, which lifts the sewage of the south side of the Thames into the old reservoir, which stores it during the rise of the tide, so that it can be discharged on the ebb stream. They are now undergoing modifications and additions, so as to adapt them to the purpose of precipitation. The works were explained by Mr. A. R. Binnie, the Chief Engineer of the London County Council.

The members subsequently returned by the *Shah* to London.

# APPENDIX.

# NOTES ON THE PAVING STONES USED AT ROCHDALE.

By S. SYDNEY PLATT, Assoc. M. Inst. C.E., Borough Engineer and Surveyor of Rochdale.

It has been well said by a great authority that "good roads are at the root of civilization," and that "no nation which ever made much progress in civilization had neglected its roads." "The nations of antiquity which have remained stationary have not been road makers. The Jews and Mohammedans were certainly not road makers."

The Romans, who were the greatest civilizers and conquerors, were also the greatest road makers, and the British within the last century or so have become great road makers, having grown into that state of civilization in which good roads are necessary.

The turnpike roads on the lines of communication between populous places were invariably formed of "macadam" (*i. e.* broken stones consolidated together by the weight of traffic or pressure in the form of heavy rollers). As towns sprang up and extended, the macadamized form of road became unsuitable on account of the frequency and expense of repairs required, and the complaints of dust in dry and mud in wet weather.

Then the material for the surface of the principal streets in towns was changed to large blocks of stone, geometrically squared, and technically known as "setts."

The locality of Rochdale is noted for stone for street purposes, obtained from the numerous quarries in the neighbourhood of Whitworth, Bacup, and Rawtenstall.

Geologically the beds from which this stone is obtained are known as "the Second Grit, or Haslingden Flags," of the Millstone Grit formation and the Carboniferous System.

On examination the stone is found to consist of "small rounded and water-worn grains of quartz, held together by a matrix or paste of decomposed felspar; interbedded are found flakes of mica. These minerals being the constituents of granite, show that this sandstone has been formed from the ruin of granitic mountains, which during the Carboniferous age, ranged to the north and north-west, far out where the Atlantic Ocean now exists; the rivers in these mountains draining into a freshwater lake or inland sea, the sediment brought

down by them was deposited in such lake, having since been consolidated into what is now known as flagstone." *

It is found from experience that the flag rock is only suitable for streets of moderate traffic, as being of a sedimentary formation it splits into layers under heavy traffic and then quickly wears away very unevenly.

When the amount of traffic exceeds certain limits, it becomes necessary to employ stones of a harder nature than those just described; these are found in the igneous, or aqueo-igneous crystalline rocks, and can only be obtained at a considerable distance from Rochdale.

"These stones are of all degrees of hardness, brittleness, and toughness, but the durability under traffic, the tendency to wear round rather than flat, and to become slippery, are dependent upon no conditions which can readily be foreseen. The size and distribution of the crystals, the nature and hardness of the constituent minerals, operate in such a manner that two opposite combinations often produce nearly the same result; while rocks of nearly equal hardness frequently behave very differently under traffic. The specific gravity, moreover, appears to afford no assistance in the determination." †

"Some people seem to think that hard stones are necessarily tough, but such is not the case. Many of the hardest stones in existence are very brittle. Toughness is occasioned by the disposition and size of the crystals forming them, these crystals being more interlocked in the tougher varieties of stones." ‡

The durability and hardness of granite are the greater the more quartz and hornblende predominate, and the less the quantity of felspar and mica, which are the more weak and perishable ingredients. Smallness and lustre in the crystals of felspar indicate durability; largeness and dullness the reverse.§

The use of hard stone for pavements is not of modern origin, for the author found that the streets of Pompeii were paved with lava stone obtained from the immediate neighbourhood; and the part of the Appian way through the Roman Forum, over which St. Paul passed, is to be seen to-day paved with similar material.

Granite was first introduced for the pavements of London from Aberdeen in 1764.

Its use in Lancashire seems to have been of more recent date, being introduced into Manchester about 1843, at the suggestion of Sir Joseph Whitworth. Before that time the pavements were

* T. Tate. † Deacon, Proc. Inst. C.E., vol. lviii.

‡ Harris, 'Granite and Granite Industries.'

§ Rankine, 'Civil Engineering.'

formed of boulder stones, gathered on the sea coasts of Wales and Cumberland.

It was introduced into Rochdale in the year 1869, the first length being laid in Smith Street, opposite the old Commissioners' Rooms.

The author some years ago prepared a cartoon plan of the Borough, showing in various colours the streets which have been paved with granite and other hard stone, each colour representing a different kind of stone. The plan is kept posted up year by year, and the dates when each length has been laid are marked thereon, so that subsequently the experience of the wear of different pavements will be furnished. Very few of the different kinds of stones called "Granite" by the "sett" trade are really granites. Granite consists of quartz, felspar, and mica; but these constituents do not as a rule form a good stone for street purposes, as it would generally prove to be too coarse grained, and would soon give way by decomposition from atmospheric influences or chemical action, and the attrition due to heavy traffic. A more satisfactory wearing stone is found where the mica is replaced by hornblende, when the petrological name is changed from granite to syenite; or when the hornblende is in combination with the mica, or only partly replaces it, when it is a syenitic granite; or when the rock again differs from a granite by being of a very close grain and minute crystals and dark colour in the form of a basalt, as in the case of the stone from the Clee Hills, Shropshire, and a similar one from the mountain of Penmaenmawr, North Wales.

The origin of these rocks is somewhat similar, as they are invariably due to volcanic agency. The description of Penmaenmawr will serve to illustrate the others.

"It is a lava very similar in its essential composition to the lavas of modern times, and is found interstratified with rocks of Cambrian age. Its fine grain, due to the minuteness of its crystals, shows that from a high temperature it had been quickly cooled, while at a great depth. If while fused it had found its way to the surface it would have formed a lava flow, but it had been consolidated beneath a series of rocks having a vertical thickness of something like two miles, all of which had to be denuded before the basalt could be exposed to the surface as it is now found." *

The following description deals with the various kinds of hard stone used in Rochdale for street purposes, commencing with the hardest and proceeding relatively to the softest.

* T. Tate.

# REFERENCE.

ALL the Sections here delineated have been drawn by the author when examined under polarized light, and are magnified about twelve diameters.

The minerals represented are referred to by the figures marked on the respective sections.

FIG. 1. PENMAENMAWR. (8) hornblende (uralitic), the ground mass is formed of felspar and interstitial glass, the black crystal at the bottom is titaniferous iron ore.

FIG. 2. CLEE HILLS. (1) Olivine, along the veins of which serpentisation has taken place as explained in the text; (10) plagioclastic felspar, showing twinning; (23, right top) epidote. the black crystals at the top are magnetite.

FIG. 3. WHIN SILL. (8) hornblende, (5) magnetite, the portion above and to the right of the figure 8, marked ×, shows a cluster of microliths of felspar, the ground mass is felspar.

FIG. 4. YR EIFL. (10) plagioclastic felspar (showing twinning on the albite type); (7) augite; (5) magnetite, the ground mass is made up of felspar with very fine grains of magnetite.

FIG. 5. LLANBEDROG. (10) plagioclastic felspar (andesine); (10A) felspar, the radiated portion shows micro-pegmatite (referred to in description), the ground mass is of fine crystals of felspar and quartz.

FIG. 6. THRELKELD. (10) plagioclastic felspar showing twinning; (10A) the same kind of felspar cut through its vertical axis, the ground mass is of fine crystals of quartz and felspar.

FIG. 7. GIMBLET ROCK, PWLLHELI. (7) ophitic augite, showing lines of cleavage; (10A) ground mass of partially kaolinized felspar; (24) microliths of quartz.

FIG. 8. BREIDDEN HILLS. (7) pyroxene (augitic); (5) magnetite; (10) felspar, much altered, partially kaolinized, the portion at the top is twinned slightly, on the left are microliths of felspar.

FIG. 9. DALBEATTIE. (8) hornblende; (10) orthoclastic felspar showing slight twinning; (24) quartz.

FIG. 10. NEWRY. (8) hornblende, the central portion showing lines of cleavage and great turbidity; (9) mica; (10) felspar; (10A) orthoclastic felspar showing zonal structure, the ground mass is coarse-grained quartz (24).

FIG. 11. Section of CLEE HILLS, showing boss of basalt erupted through carboniferous strata.

## No. 1. Penmaenmawr, North Wales.

The mountain of Penmaenmawr, from which this stone is obtained, is composed of a crystalline felspathic rock, which has been erupted through Silurian strata, and rises to a height of 1553 feet above the sea level, forming a boss-like elevation two miles in length and one in width.

This stone varies in colour from a green to a greenish-grey, sometimes a dark slaty-grey, to almost black.

There are several quarries on the mountain, and "there is a great difference chemically and commercially between the stone obtained from different parts of it." *

In the 'Memoir of the Geological Survey for North Wales,' Prof. Ramsay characterised it as "chiefly consisting of small felspar crystals, occasionally associated with a very small proportion of hornblende." It is also classed as "a felspathic greenstone." † Mr. J. A. Phillips, F.G.S., in a paper in the 'Quarterly Journal of the Geological Society,' 1877, vol. xxxiii. p. 423, gives a detailed account of the varieties to be observed in the mass; analyses showing the different stages of alteration, and a description of the mineralogical character as determined microscopically, and says "the stone appears to consist of felspar associated with minute crystals of some dark hornblendic or pyroxenic mineral."

Mr. J. J. H. Teall, F.G.S., in the 'Quarterly Journal of the Geological Society,' vol. xl. p. 656, in comparing a somewhat similar stone from the North of England, says that under the microscope the Penmaenmawr rock is seen to consist of bronzite (which he thinks is the dark hornblendic crystal referred to by Mr. Phillips, as the modern methods of recognising the rhombic pyroxenes were not then so generally known), monoclinic pyroxene, plagioclase, titaniferous iron ore, and quartz, both in the grains and associated with felspar in micro-pegmatite." And the same writer, in his work on 'British Petrography' refers to it as a bronzite-diabase, and also as enstatite-diorite. Professors Judd and Rosenbusch both speak of the Penmaenmawr stone as an enstatite-diabase. (For microscopic section see Fig. 1.)

There were four quarries on this mountain; the two easterly were worked by Messrs. Kneeshaw, Lupton and Co., but now the easterly middle one is worked by Messrs. Darbishires, the most easterly being abandoned as unsuitable material for paving setts. The westerly quarries are worked by Messrs. Brundrit and Co.

The stone of the most easterly, and similar stone in part of the

* Warington Smith.

† Catalogue, Museum of Practical Geology.

westerly quarries, known as the old Blue Penmaenmawr stone, has not been used now for some years, as being very close-grained and showing a conchoidal fracture, it is considered unsuitable for paving setts, on account of its great tendency to become very slippery under traffic.

The grey variety from both quarries, which is now being used for that purpose, being coarse-grained, appears to afford a safer foothold for horses in suitable situations.

"The Penmaenmawr stone possesses very slight porosity, the absorption being less than 0·03 per cent. of its weight, an important characteristic as regards disintegration by atmospheric influences, or by chemical action consequent upon contact with animal droppings or other street refuse, or by the action of frost, stones of slight porosity being best able to withstand such actions." *

Several chemical analyses of the stone are given in the 'Quarterly Journal of the Geological Society,' vol. xxxiii. p. 423, including those of the stone not now used, and of several veins prevalent in the rock.

There is also a good description of the different varieties of this rock by Mr. T. H. Waller, B.Sc., in 'Midland Naturalist,' January 1885 (vol. viii. p. 1).

The following analyses are of the grey variety now being used:—

| | From Messrs. Brundrit & Co.'s Quarries. | From Messrs. Darbishire's Quarries. |
|---|---|---|
| Silica | 56·25 | 59·95 |
| Alumina | 18·02 | 16·43 |
| Peroxide of iron | 3·81 | 6·43 (Peroxide of iron, Protoxide of iron, Oxide of manganese together) |
| Protoxide of iron | 3·70 | |
| Oxide of manganese | Trace | |
| Lime | 6·90 | 7·43 |
| Magnesia | 5·04 | 4·42 |
| Potash | 2·76 | 2·00 |
| Soda | 1·90 | 2·80 |
| Carbonic acid | 0·50 | — |
| Sulphuric acid | 0·03 | — |
| Combined water | 1·09 | 0·54 |
| | 100 00 | 100·00 |
| Specific gravity | 2·76 | 2·69 |
| | Mr. Norman Tate. | Dr. Frankland. |

The crushing strength is placed at 26,837 lb. per square inch.†

This stone has not been laid in Rochdale during the last few years. The variety used, although not being the old Blue Penmaenmawr referred to, is not quite so coarse-grained as the grey varieties now being quarried. It is suitable for very heavy traffic on flat gradients,

* Norman Tate.

† Reid's 'Concrete.'

but it is not advisable to use it at the intersection of streets, where horses are inclined to slip on turning on a very hard stone.

Large quantities have been used along the line of docks, Liverpool, where the heaviest traffic prevails; Manchester, and other large towns.

No. 2. Clee Hill, near Ludlow, Shropshire.

This is a basalt composed principally of augite, olivine, and felspar; it has somewhat the same characteristics as No. 1.

Mr. S. Allport, F.G.S., in the 'Quarterly Journal of the Geological Society,' vol. xxx. p. 530, refers to this and similar rocks as "Dolerite."

A description of the relation of this intrusive boss and its effect on the Carboniferous strata through which it has been erupted (see Fig. 11), and a photographic view of the quarry face, will be found in the 'Proceedings of the Manchester Scientific Students' Association' for 1881.

A paper on the "Geological Structure of the Titterstone Clee Hill" appears in the 'Midland Naturalist' for August 1885 (vol. viii. p. 220).

In the microscopic section of this rock (Fig. 2) the minerals represented are—olivine, augite, epidote, felspar (plagioclastic), and magnetite. The large olivine in the figure is not an individual, but an aggregate of several grains. Serpentisation has taken place along the boundaries of the different grains, and in one or two cases along cracks, traversing individual grains. The olivine is distinctly coloured, and so that it seems reasonable to infer that it is rich in iron. Augite occurs in small crystals, grains, and granular aggregates, and is brown in colour. Felspar plays the rôle of ground mass in the rock, and occurs in forms giving lath-shaped sections, and also in more or less irregular grains or plates.

There is no information to hand of the chemical composition of this rock; its specific gravity is 2·867, and the crushing weight is 28,122 lb. per square inch.*

This stone is suitable for same situations as No. 1, and the same precautions are necessary. Some of this stone used in Rochdale has shown a marked disposition to split obliquely under heavy traffic (e.g. traction engines), but as it was supplied from more than one quarry, it is not possible to distinguish which; the author's belief is that the split stone is "bearing" or top rock, which ought not to have been sent for street pavements. Stone from the same quarries used in Bolton and other towns has not exhibited this characteristic. It has been used to a considerable extent on the tramways where they run along the macadamised roads in the suburbs.

This and the Penmaenmawr stone are considered amongst the best obtainable for repairing macadamised roads.

* Kirkaldy.

## No. 3. Whinstone.

From various quarries in the north of England, and from a dyke called the "Whin Sill," which extends across Durham, Cumberland, and Northumberland, and partly in north-east Yorkshire. —"This is an intrusive rock of a later period than the Carboniferous formation." "The rock is dark-grey or bluish-grey when freshly exposed. In texture it varies from compact to coarsely crystalline, the most common variety being the latter. The only constituents distinctly recognisable with the hand lens are pyroxene, a light-coloured substance which is presumably either felspar or the result of its alteration, and a few specks of pyrites. Under the microscope the essential constituents are seen to comprise plagioclase of one or more species and generally more or less altered, and monoclinic pyroxene, and titaniferous magnetic iron ore. In the coarse-grained varieties quartz may always be detected as an original, and probably also as a secondary, mineral. The original quartz is intergrown with felspar so as to produce the micro-pegmatite structure of Lévy and Fouqué." "There are some very interesting points, both of resemblance and difference, between the Whin Sill and the eruptive rock of Penmaenmawr, described by Mr. J. A. Phillips ('Quarterly Journal of the Geological Society,' vol. xxxiii. p. 423). These two rocks are composed of the same minerals, associated in very different proportions. The Penmaenmawr was seen under the microscope to consist of bronzite, &c. (see No. 1). In the Whin Sill the monoclinic pyroxene is largely in excess of the bronzite, but in the Penmaenmawr rock the reverse relation holds—the bronzite is very largely in excess. A comparison of the bulk-analyses shows that the Penmaenmawr rock possesses a larger proportion of felspar than the Whin Sill.—J. J. H. Teall, 'Quarterly Journal of the Geological Society,' vol. xl. pp. 640, 656.

The following is an analysis of the Whin Sill ('Quarterly Journal of the Geological Society,' xl. p. 654).

| | |
|---|---|
| Silica | 51·22 |
| Alumina | 14·06 |
| Titanic acid | 2·42 |
| Peroxide of iron | 4·32 |
| Protoxide of iron | 8·73 |
| Oxide of manganese | 0·16 |
| Lime | 8·33 |
| Magnesia | 4·42 |
| Potash | 1·25 |
| Soda | 2·55 |
| Bisulphide of iron | 0·49 |
| Carbonic acid | 0·19 |
| Phosphoric acid | 0·25 |
| Water | 1·28 |
| | 99·67 |

Its specific gravity is 2·98, and its crushing strength is 25,702 lb. per square inch.*

This stone is very similar in appearance and wearing characteristics to No. 2 (Clee Hills). It has been used on the tramways which pass along the macadamised roads in the outskirts of the town, but not by the Corporation.

### No. 4. Welsh Granite,

from the mountain peaks of Yr Eifl (The Rivals), situate about fifteen miles south-west of Carnarvon.—"The igneous rocks of Yr Eifl come up in irregular masses and clearly overlie the Ordovician slates after the manner of intrusive igneous rocks. They show a rather remarkable system of horizontal (columnar ?) jointing which gives them a very bedded aspect as seen from a distance, disappearing on closer examination.† It is a very hard, compact, close-grained stone, composed of white crystals of felspar mixed with smaller grains of yellowish red-coloured felspar, dark specks of hornblende, and small particles of quartz, the whole forming a fine-grained 'Syenite.'"‡ The late Director-General of the Geological Survey (Sir A. Ramsay), referred to it as "a felspar porphyry, often very syenitic."

From a microscopical examination by the late Prof. Phillips (who was considered one of the greatest authorities on Petrology), he characterised it a true granite, containing the following minerals: felspar (orthoclastic and plagioclastic), mica (magnesian), quartz, magnetite, ilmenite, apatite, epidote, serpentine, chlorite, kaolin, but no hornblende. The microscopic section, Fig. 4, however, shows augite.

Prof. Harker, Cambridge University, also refers to this rock as "augitic-granite-porphyry, more or less granophyric." "The ground mass has the character of a very fine-grained granite. The felspar is fairly well developed and sometimes shows twinning (see Fig. 4). It often gives squarish sections, which no doubt belong to orthoclase; occasionally others have the appearance of microline, and an acid plagioclase is also found in a few cases. The quartz is interstitial to the felspars." §

It is a very tough rock, the corners are not so apt to wear round and for that reason not so slippery, and is one of the most suitable stones for flat gradients subject to heavy traffic. Most of the granite paving laid in Manchester is of this stone, and the same may be said of Rochdale. And in such of these streets in Rochdale as have not been disturbed by sewerage operations, although subject

* Kirkaldy. † Blake, Brit. Assoc., 1886, p. 669.
‡ Tennant. § Bala Volcanic Series, 1889.

to heavy traffic, there has not been a penny spent for repair since they were laid down about twenty years ago, nor are they likely to do under similar conditions for the next fifty years.

"The rate of wear has, under the heaviest traffic in Liverpool, not exceeded one-fiftieth of an inch per annum."* Its specific gravity is 2·63. It is the only paving stone which can withstand the damage usually done by traction engines, as it does not split, nor are the arrises (edges) so much abraded as in the case of the other stones used.

### No. 5. Llanbedrog, Carnarvonshire,

four miles south-west of Pwllheli.—"The rock consists of a pale grey ground-mass, sometimes light brown, of crystallo-granular texture, in which are embedded numerous crystals of felspar, with sharply-defined outline and opaque white colour. Under the microscope the ground mass is seen to be composed of small crystals and crystalline grains of felspar and quartz, the felspar being exceedingly turbid. In the microscopic sections the large included crystals of felspar allow but little light to be transmitted; yet the twin-striation of plagioclase is clearly discernable in some of them. There are probably two distinct felspars in the rock. A few irregular patches of a dark green dichroic mineral, mainly chlorite, are scattered through the base, and may have resulted from the alteration of a magnesium mica; while the chlorite itself is partly converted into epidote. There is a little calcspar or dolomite in the rock. It is notable that around the edges of many of the large crystals of felspar are some beautiful examples of that peculiar associatra of quartz and felspar which is known as Micropegmatite (see microscopic section, Fig. 5). The rock would be called by some German petrologists a Granitporphyr."†

On account of its porphyritic texture it should maintain a rough surface under wear. Its specific gravity is light (2·53) and its crushing strength is 20,711 lb. per square inch.‡ It has not been tried long in Rochdale, but is well spoken of elsewhere where it has been in use, as moderately durable and not slippery.

### No. 6. Threlkeld, St. John's Vale, near Keswick, Cumberland.

This is a close-grained stone of a greyish colour, and is known as a quartz-porphyry, and also as a quartz-felsite, (St. John's quartz-felsite), the mineral constituents being orthoclase and microline felspars, quartz, calcites, a little epidote, and serpentine, some of

* Deacon. † F. W. Rudler. ‡ Kirkaldy.

which have apparently replaced mica.* "The crystals of quartz and felspar are enclosed in a felsitic base, and there are occasionally fan-shaped crystals of schorl. The oligoclase, which is much altered, is of a yellowish green colour; crystals of blende and galena have been found in some of the joints. At the eastern end of the quarry the intrusive rock may be seen in contact with the Skiddaw slate, which is here much folded and crumpled.†

The annexed analysis and further information as to this stone, by Mr. J. Clifton Ward, F.G.S., appears in the 'Quarterly Journal of the Geological Society,' vol. xxxii. (1876), and in his 'Survey Memoir of the Geology of the Northern part of the Lake District,' in both of which also appear micro-sections of the rock, in the latter work being coloured.

The following is an analysis of this rock:—

| | |
|---|---|
| Silica .. .. .. .. .. .. .. .. | 67·180 |
| Alumina .. .. .. .. .. .. .. | 16·650 |
| Lime .. .. .. .. .. .. .. .. | 2·352 |
| Magnesia .. .. .. .. .. .. .. | 1·549 |
| Potash .. .. .. .. .. .. .. .. | 2·914 |
| Soda .. .. .. .. .. .. .. .. | 4·032 |
| Ferrous oxide .. .. .. .. .. .. | 2·151 |
| Ferric oxide .. .. .. .. .. .. .. | 0·559 |
| Phosphoric acid .. .. .. .. .. .. | 0·179 |
| Sulphuric acid .. .. .. .. .. .. | trace. |
| Carbonic acid .. .. .. .. .. .. | 0·885 |
| Carbonaceous matter .. .. .. .. .. | 0·797 |
| Water .. .. .. .. .. .. .. .. | 0·752 |
| | 100·000 |

The specific gravity is similar to No. 4, viz. 2·63, and the crushing strength is 20,128 lb. per square inch.‡ It has not been tried sufficiently long to determine its wearing characteristics, but the experience so far has been favourable, as it appears suited to heavy traffic on moderate gradients and not to wear slippery.

### No. 7. Gimblet Rock, Pwllheli.

This is obtained from an isolated rock forming the termination of a small peninsula near Pwllheli, locally known as Careg-y-Rimbill (The Gimblet Rock), and is a "small, coarse-grained greenstone in which the hornblende predominates over the felspar."§ It is also referred to as a medium-grained, dark, greenish grey, granular rock

* Rutley. † Postlethwaite's 'Mines and Mining in the Lake District.
‡ Kirkaldy. § Ramsay, 'Geol. Survey North Wales.'

—not unfrequently showing lustre-mottling. Under the microscope it is seen to have consisted originally of large ophitic masses of augite, columnar (lath-shaped in section) plagioclase, and irregular plates of ilmenite. The lustre-mottling is due to the fact that the ophitic masses of augite are penetrated by felspar. The ilmenite is almost always more or less changed to leucoxene. The felspars are cloudy and frequently contain spots and patches which appear snow-white by reflected light, and opaque or nearly so by transmitted light, in consequence of alteration. The general absence of olivine from this kind of rock is an important characteristic feature.* It is also referred to as "diabase," and as being "decidedly basic in constitution." In the quarry can be noticed segregation or contemporaneous veins, which represent the latest phase in the process of consolidation. These veins are generally more felspathic and of a lighter colour than the rest of the rock, of coarser grain, and frequently have the augite idiomorphic, while in the matrix it is intersertal or usually ophitic. Such veins occur pretty numerously and have a rough parallel or subparallel arrangement.† The stone is free from slipperiness, very tough, difficult to dress into setts, and wears to a flat surface. It has been successfully used in Rochdale on very steep gradients, e.g. 1 in 13 and 1 in 14, and on gradients of 1 in 20 to 1 in 30; and whilst it is free from slipperiness has a moderate durability, but of course not equal to most of the previously described stones.

The following shows the analysis of the Gimblet Rock :—

| | |
|---|---|
| Silica | 46·65 |
| Alumina | 21·33 |
| Peroxide of iron | 3·69 |
| Protoxide of iron | 5·79 |
| Oxide of manganese | trace. |
| Lime | 8·29 |
| Magnesia | 8·06 |
| Potash | 1·25 |
| Soda | 1·58 |
| Carbonic acid | 0·95 |
| Sulphuric acid | 0·16 |
| Combined water | 2·25 |
| | 100·00 |

NORMAN TATE.

The specific gravity of this stone is 2·92, and its porosity was equal to an absorption of only 0·03 per cent. of its weight of water.

* Teall's 'British Petrography.'
† Harker, 'Bala Volcanic Series,' Cambridge, 1889.

### No. 8. Shropshire.

This is a greenish coloured stone from the neighbourhood of Breidden Hills, on the borders of Shropshire and Montgomeryshire. The quarry is at present closed for want of railway accommodation.

A geological section through the Breidden Hills appears in Murchison's 'Siluria,' p. 80.

The stone is classed as an andesitic lava. Microscopically it is dark grey or dull greenish in colour.

Microscopically the porphyritic constituents are felspar and pyroxene, the crystals of the former rarely exceeding 0·1 inch in length, those of the latter being smaller. The ground mass is a "mikrolithen filz" (Ger.), a *felted* aggregate of microlites or slender needle-like crystals. Owing to alteration, the porphyritic felspar are often turbid. The pyroxene is mainly rhombic, but monoclinic augite, often more or less changed to chlorite, is also present.*

The microscopic section No. 8 also shows magnetite.

The stone is somewhat similar in appearance to No. 7, but darker; it is also similar in another feature, viz. a tendency to wear to a flat surface, which renders it very comfortable to drive over, and it is not slippery. It is, however, inclined to split obliquely under traffic and to wear unevenly, as some stones become crushed. Only one street in Rochdale has been paved with this stone.

The specific gravity is about 2·66.

### No. 9. Dalbeattie, Kircudbrightshire.

This is a very coarse-grained stone, composed of white and brown felspar, quartz, and black mica, of which the felspar predominates. "It may be described as a granitite, or hornblende-granitite, containing much sphene. The plagioclase frequently shows a zonal structure, and is often idiomorphic with respect to quartz." † The micro-section No. 9 shows hornblende, quartz, and felspar. "Very little information has been published about this stone. Its specific gravity is 2·67, porosity *nil*, and crushing weight 14,071 lb. per square inch." ‡

This stone wears faster than any of the preceding, except No. 8. On account of its freedom from slipperiness it is very suitable on steep gradients and at the intersection of busy thoroughfares. It has been successfully used on gradients of 1 in 13 and 1 in 20.

* Watts, Q. J. G. S., vol. xli.

† Teall's 'Brit. Petrography.'

‡ Kirkaldy.

## No. 10. Newry, Ireland.

Granite from this neighbourhood has been obtained from two quarries, one near Goragh Wood; and another near the town of Newry (now closed) the latter worked by the late Mr. James Savage. They are both coarse-grained, and macroscopically appear to be composed of felspar, quartz, and black mica, the predominant crystal being felspar. "It occasionally becomes porphyritic by enclosing fragments of felspar imbedded in a fine-grained ground mass of a bluish-grey colour (e.g. at Goragh Wood). Examined under the microscope, this granite is seen to be composed of quartz, orthoclase, a felspar exhibiting cross-striation, a very few small crystals of a distinctly triclinic felspar, a dark or black mica, green hornblende, sphene, a few needles of apatite, with occasionally magnetite, pyrites, and perhaps a little rutile." *

The chemical analyses of the granites of the Newry district by Dr. Haughton are:— †

| | Newry Granite. | Goragh Wood Granite. |
|---|---|---|
| Silica .. .. .. .. .. .. | 64·60 | 62·08 |
| Alumina .. .. .. .. .. | 14·64 | 15·92 |
| Peroxide of iron .. .. .. .. | 6·04 | 7·72 |
| Lime .. .. .. .. .. .. | 3·16 | 5·52 |
| Magnesia .. .. .. .. .. | 2·80 | 2·16 |
| Potash .. .. .. .. .. .. | 3·15 | 2·19 |
| Soda .. .. .. .. .. .. | 4·02 | 3·34 |
| Loss by ignition (water) .. .. | 1·13 | 0·89 |
| | 99·54 | 99·82 |

The crushing strength of Newry granite is given at 13,440 lb. per square inch.‡

Whilst this granite is specially suitable for steep gradients and the intersection of busy thoroughfares on account of its freedom from slipperiness, it is not in favour on account of its rapid and uneven wear; as, like some other Irish granites, it has a tendency to decompose, particularly that from Mr. Savage's quarry. This is probably owing to the felspar containing an excess of lime and soda, which renders it more liable to decay, and also to the black mica, which is freely distributed, being easily decomposed and therefore a further source of weakness.

Paving stones of this material have been taken up which have been

* Phillips, Q. J. G. S., vol. xxxvi. p. 16.
† Q. J. G. S., xiv. p. 303.
‡ Wilkinson's 'Practical Geology of Ireland,' 1845.

found to be worn away as much as 1½ inch in depth in twelve years, whereas some of the hardest previously described have not lost ¼ inch in depth in that time. It has been used on gradients of 1 in 13 to 1 in 20, and at several street intersections. Its use is now confined to the latter.

Complaints have occasionally been made about the slipperiness of streets paved with the stones numbered 1 to 4: it is true that they are liable to become so in dry weather, and that years ago some of these stones were placed in unsuitable situations, e.g. on gradients steeper than now thought advisable, and at the intersections of busy thoroughfares where horses are inclined to slip on hard stones when turning a corner, or where there is much difference in level between one side of a street and the opposite. But the author's experience and practice justifies him in saying that when proper care is exercised in placing such stones in suitable situations, and in using coarser-grained stones such as Nos. 7, 8, 9, and 10 at the intersection of busy streets, no complaints will arise. It becomes daily more imperative to pave the surface of the streets forming the principal lines of communication and where the heaviest traffic is concentrated, with the stones No. 1 to 6 (in suitable situations), for they are exceedingly durable and from their economy eminently fitted for the ratepayers, whatever they may be for equestrians.

The author hopes at no very distant date to publish similar notes on many other stones used in this country for paving or macadam, and will be glad of any information thereon.

Returns or Books of Statistics on the following subjects lie at the Offices of the Association, 11, Victoria Street, Westminster, S.W., and are open to the inspection of members.

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1. Particulars of Sewage Purification and Disposal. Returns from 41 towns. Compiled by H. Richardson, A. M. Inst. C.E., Town Surveyor, Oldbury. 1890.

2. Statistics relating to Water Supply for Domestic, Trade, Sanitary, Street-watering, and Public Purposes. Information from 111 towns. Compiled by J. T. Eayrs, A. M. Inst. C.E., Borough Surveyor, West Bromwich. 1890.

3. Comparison of Cost and Life of Granite and Gritstone Pavement. Information received from 33 towns. Compiled by C. F. Wike, M. Inst. C.E., Borough Surveyor, Sheffield. 1890.

4. The Collection of House Refuse. Returns from 89 towns. Compiled by J. Price, A. M. Inst. C.E., Surveyor to the Local Board, Toxteth Park. 1891.

5. The Disposal of House Refuse, &c. Returns from 39 towns Compiled by J. Price, A. M. Inst. C.E., Surveyor to the Local Board, Toxteth Park. 1891.

6. Particulars respecting Tar Macadam. Returns from 72 towns. Complied by Joseph Hall, A. M. Inst. C.E., Borough Surveyor, Cheltenham. 1891.

7. Information on the Working of Shone's Hydro-Pneumatic System. Returns from 20 towns. Complied by E. Buckham, M. Inst. C.E., Borough Surveyor, Ipswich. 1891.

# VOLUNTARY EXAMINATIONS.

## SYLLABUS.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS have undertaken the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

Two Examinations are held in each year; one in April, in London, and one in October, in some provincial town to be fixed on by the Council and advertised in the *Builder* six months beforehand.

The Examinations are by written papers and *vivâ voce*, upon the four following subjects:—

1st. Engineering as applied to Municipal Work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Public Health Acts, and Rivers Pollution Acts.

Examples of the class of questions proposed to be asked under these heads are appended hereto.

Candidates are allowed two hours to answer the questions under each of the four heads, and are not necessarily required to answer all the questions set in each paper, though not less than four must be taken: marks are given for all questions properly answered. The *vivâ voce* examination is held after the written papers have all been sent in, and is directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations extend over one or two days, as circumstances may require, and in the latter case the arrangements will be, as far as possible, as follows:—

| | | | | | |
|---|---|---|---|---|---|
| First day .. | 10 | to | 12 | .. | Engineering. |
| " .. | 2 | " | 4 | .. | Building Construction. |
| " .. | 5 | " | 7 | .. | Sanitary Science. |
| Second day .. | 9.30 | " | 11.30 | | Public Health Law. |
| " .. | 1 | " | 4 | .. | *Vivâ voce* Examination. |

The total number of marks required to constitute a pass is 50 per cent. in each of the subjects.

Each candidate has to fill a Form of Application, to be obtained from the Secretary.

The fee for each Examination is 3*l.* 3*s.*, one guinea to be paid on application, and the balance on the day of examination. Should the candidate fail, he will be entitled to present himself again at the next, or any subsequent Examination, on payment of one-half of the above fee.

No further charge will be made to the candidate than the fees above mentioned.

Candidates that do not present themselves for the Examination forfeit the entrance fee.

Successful candidates are entitled to receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

Further details and particulars may be obtained on application to Mr. Thomas Cole, Secretary to the Association, 11, Victoria Street, S.W.

## SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work:

A. Land Surveying and Levelling.
B. Hydraulics.
C. Drainage and Sewerage.
D. Water Supply.
E. Road Making.

II.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.

III.—Sanitary Science as applied to Towns and Buildings:

A. Ventilation.
B. Sewage Disposal.
C. House Drainage.

IV.—Public Health Acts.
Rivers Pollution Acts.

## TENTH EXAMINATION.

The Tenth Examination of candidates was held at the Offices of the Association, Westminster, on the 3rd and 4th October, 1890, at which the following Examination Papers were set to the candidates.

### SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

*Examiner:—James Lemon, M. Inst. C.E.*

1. *Surveying.*—Sketch the main lines and ties you would chain in surveying the streets on the accompanying plan.
2. How would you measure the width of a river?—Make a sketch.
3. *Levelling.*—A sewer has a fall of 1 in 350, the reduced level at the lower end is 8·22, what would be the level at a distance of 920 feet? What length of boning rod would you tell the workmen to use, and at what level would you fix the sight rails at each point, the depth of the invert below the surface of the ground averaging about 6 feet?
4. *Hydraulics.*—What would be the velocity and discharge of an 18-inch pipe sewer running half full and one-third full, with a gradient of 1 in 350?
5. What would be the velocity and discharge of a sea outfall at high water, 1¼ mile in length, 18 inches in diameter, gradient 1 in 520, depth of invert at lower end of pipe 10 feet below high water?
6. *Drainage and Sewerage.*—Show how you would drain an estate as shown on the accompanying plan, giving levels and gradients of proposed sewers.
7. If you have to design a sewage reservoir in two compartments 8 feet in depth, 30 feet in width, what thickness would you make the division wall and the external walls?—Show a cross section of the walls and bottom, with figured dimensions thereon.
8. *Water Supply.*—Give a sketch of an ordinary filter for a town of 30,000 inhabitants, deriving its supply from gathering grounds or from a river. State how many yards super you would allow.
9. A town of 30,000 inhabitants is to be supplied from wells; what storage reservoir would you specify? What diameter of pumping main for a distance of one mile?
10. *Road Making.*—Sketch cross sections of roads 40 feet in width, to be made with macadam or paved with granite setts, the footpaths paved in each case.
11. Give an estimate of the quantity of materials in Question 10 per yard run.
12. Give a sketch of a gully in a *flat* road, and for one with a *very steep* gradient where there would be a great quantity of silt washed down in heavy rains.

SUBJECT:—BUILDING CONSTRUCTION, &c.

*Examiner:—J. Lobley, M. Inst. C.E.*

1. Write a specification for mortar. What are the common faults of mortar in improper work, and how are they detected?

2. Write a specification for brickwork. Describe the different kinds of bond, and when they may be advantageously adopted.

3. Describe the following terms used in plumbing work—valleys, gutters, step-flashing. State weight of lead for each purpose.

4. Write a specification for Carpenter and Joiner for a dining-room floor complete, with joists, skirting, bridging, fireplace, &c.; dimensions of room, 18 feet by 14 feet. Draw a cross section, 2 feet to 1 inch scale.

5. Draw a plan and section of a two-storied house, 15 feet frontage—one of a terrace. The depth of land between front street and back street is 60 feet. Show the outbuildings and describe the requirements of the Model Bye-Laws as to space at the rear. State how the measurements across the yard space should be taken.

6. Describe the composition and manufacture of Portland cement, and the usual tests for the same.

7. Make a specification for a fireproof floor for the following corridors in a public building. Draw to scale, 4 feet to 1 inch, a corridor 6 feet wide, crossing a corridor 9 feet wide at right angles. At the intersection of the corridors make a hall 16 feet square; show positions and sizes of joists. Make a cross section 2 feet to 1 inch through the hall, showing girders, &c., with figured dimensions.

8. Draw roughly a section of a four-storied house, ground floor, first, second and third floors; kitchen on ground floor, bath on first floor, cistern on third floor. Show the lines of flow and return for hot water supply to various parts, low pressure system with cylinder. Give explanation of the circulation.

9. The front main wall of a row of shops is 14 inches thick 20 feet high above shop windows. State strength and dimensions of wrought or cast iron girders to support same over spans of 17 feet. Show the calculation.

10. Sketch a queen-post roof truss for a span of 60 feet. State distance apart desirable. Figure dimensions of timbers, selecting your own conditions as to pitch and covering. Show by letters C and T, which parts are in compression or tension.

11. Sketch a wrought iron truss for a similar roof, and proceed as in previous question.

12. Sketch the shoring requisite for supporting the front wall of a building 40 feet in height during the re-building of adjoining premises. Figure the dimensions.

## Subject :—Sanitary Science.

*Examiner :—T. De Courcy Meade, A. M. Inst. C.E.*

1. What *cubic space* would you allow in an ordinary sleeping apartment for each adult, and what provision (if any) would you make for the ventilation of such an apartment other than by door, windows, and chimney?

2. What cubic space would you allow per patient in a *fever ward*?

3. How would you *heat* and *ventilate* the wards of a fever hospital?

4. Sketch a plan and section of a shop—

   (*a*) Abutting on a street in front.

   (*b*) Adjoining buildings on each side.

   (*c*) Having a basement with floor 7 feet below the street level and 3 feet above the invert of sewer in street, the sewer being 12 inches in diameter and 20 feet from front of building.

   (*d*) There being a w.c. and sink on *ground* floor at rear and a sink in front in the basement.

   Show clearly the method you would adopt for draining the building, and describe the materials, and the size, form, and inclination of the drains, method of jointing same, and the fittings and appliances you would use. The sketch need not be to scale, but the information should be sufficient to enable a contractor on visiting the building to measure up and estimate for the drainage and sanitary fittings.

5. The sewage of a water-closet town of 20,000 inhabitants, having a separate system of sewerage, is to be treated on 10 acres of land, the outfall sewer entering the land at the surface level, the effluent discharging into a small brook 5 feet below the level of the invert of outfall sewer, the land to be of any suitable shape. Describe fully the method you would adopt, and clearly illustrate the arrangement, giving size of tanks, filters, &c., arrangement of machinery, what chemicals (if any) to be used, and the quantity of same to be employed per million gallons of sewage, the estimated quantity of sewage to be treated per twenty-four hours, and the greatest flow at any period during the twenty-four hours. Show how you arrived at these figures.

### Subject:—Public Health Acts and Rivers Pollution Acts.

*Examiner:—W. Santo Crimp, M. Inst. C.E.*

1. What is the legal distinction between a "drain" and a "sewer"?
2. All existing and future sewers within the district of a local authority shall, with certain exceptions, vest in, and be under the control of such local authority. What sewers are specially excepted?
3. What obligations are imposed upon local authorities with regard to the sewers under their charge?
4. Under what conditions may the owner or occupier of premises within the district of a local authority cause his drains to empty into the sewers of the local authority?
5. A local authority alters or adds to its sewerage system; upon whom devolves the duty of altering an existing house drain which is no longer adapted to the altered conditions?
6. Before commencing to construct waterworks within the limits of supply of any authorised water company, certain conditions are to be observed by the local authority desirous of constructing such works. What are the conditions referred to?
7. What duties are imposed upon local authorities who are the owners of waterworks, as to providing a proper supply of water?
8. Specify the principal subjects with regard to which a local authority may make bye-laws?
9. What are the preliminary steps to be taken by a local authority under the 150th Section before making up a private road?
10. In the event of a fire, or other cause rendering it necessary to take immediate steps with regard to a building which has become dangerous, what course may be taken, and under what Act may the local authority proceed?
11. Specify some of the main provisions with regard to contracts.
12. What is the principal object of Part II., Section 3, of the Rivers Pollution Prevention Act, 1876.

Eight candidates presented themselves for examination, of whom the following six satisfied the Examiners, and were granted their certificates of competency:—

Ball, C. F. (Croydon).
Dyack, W. (Aberdeen).
Edge, F. J. (Barrow-in-Furness).
Hall, W. (Ealing).
Manley, J. (Market Harbro').
Sumner, F. (Kilburn).

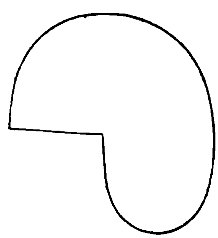
## ELEVENTH EXAMINATION.

The Eleventh Examination was held at the Institution of Civil Engineers, Westminster, S.W., on the 17th and 18th April, 1891, when the following Examination Papers were set to the Candidates.

### SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

*Examiner:—E. B. Ellice-Clark, M. Inst. C.E.*

1. What are the principal errors in levelling; describe the error of collimation?
2. Draft a form of Level Book, write heading of each column, and give example of levelling. Describe what is meant by Ordnance Datum.
3. What is the best system of paving the carriage-ways of streets having a traffic of 100,000 tons per annum per yard of width? Sketch cross section.
4. Sketch section of carriage-way paved with wood, giving explanatory notes.
5. In a perfectly level street, how far apart should the rain-water gullies be placed? Give longitudinal section of channels, with gradients.
6. Give formula for the discharge of circular sewers, and what is the rule for ascertaining the hydraulic mean depth of oval sewers?
7. How would you ascertain the quantity of water passing into town sewers during heavy falls in short periods? Describe why different areas of the same town would contribute different quantities to the sewers with a given rainfall.
8. What are the advantages or otherwise of this (Paris) form of sewer?



9. Sketch bell-mouth junction of sewer with manhole.
10. In designing a system of sewers for a town (which name), what volume of sewage would you make provision for? Describe the methods you would adopt in disposing of the storm water.
11. Sketch in red, on the accompanying plan, a scheme for dealing with the sewers interfered with by proposed new railway which severs the sewers north and south; also the brick trunk sewers, Nos. 1, 2 and 3. Write description of scheme.

## Subject:—Building Construction, &c.

*Examiner:—T. De Courcy Meade, M. Inst. C.E.*

1. Sketch the centering for a brick arch of 45-feet span, and rise of 15 feet to carry a 40-feet roadway over a river, there being no intermediate supports, the height of abutments from bed of river to springing of arch being 13 feet. Figure dimensions of timbers, show-bolts, straps, &c., and provision for removing centering.
2. Sketch a wooden stairs with half-space landing—width between walls, 6 feet; length from first riser to wall at back of landing, 12 feet 6 inches; height from floor to floor, 12 feet. Name the different parts, and figure dimensions.
3. Write a short specification for painters', paperers', and glaziers' work for a ten-roomed dwelling-house, to let at about 45*l.* per annum.
4. Sketch and name the various bonds in brickwork, and state the advantages or disadvantages of each.
5. Sketch a bay window with folding shutters, showing clearly the construction, with figure dimensions and names in detail.
6. Write a specification for Portland cement.
7. State the names by which slates of the following sizes are known, viz:—
   26 × 16   24 × 14   24 × 12   18 × 10   16 × 8   13 × 6   12 × 8
   State which size you would prefer for roofing an ordinary dwelling-house, the lap, method of fixing, and the number of slates required per square.
8. Specify York stone for yard or other paving.
9. Sketch an iron roof with a span of 35 feet in the clear, the roof covering to be of slate. Figure dimensions of ironwork, and show directions of strains by arrows, distinguishing those members in tension from those in compression.
10. Sketch a ledged and braced door, a framed and braced door, and a six-panelled door, naming the different parts.

## Subject:—Sanitary Science.

*Examiner:—James Lemon, M. Inst. C.E., F.R.I.B.A., &c.*

1. How would you ventilate a Council-chamber 40 feet by 25 feet by 17 feet high?
2. How many superficial feet and how many cubic feet would you allow per patient in a fever ward?
3. In designing a separate system of drainage, how would you calculate what is due to what is called *unavoidable* rainfall; that is, the quantity which cannot be kept out of the sewers?

4. State your reasons for disposing of sewage by irrigation, or by intermittent filtration, or by precipitation, or by a combined system.
5. What chemicals, and what quantity thereof, would you recommend for the precipitation of a million gallons of sewage from an inland town?
6. How would you dispose of the sludge, and what quantity of water does ordinary sludge contain?
7. The sewage from 10,000 persons is to be precipitated in tanks; how many would you provide, and what sizes?
8. If it be necessary to filter the effluent of precipitation, what filtration would you advise, and give the area per million gallons of sewage per diem?
9. Draw sketches of connections to house drain from w.c., sinks, bath, &c., showing ventilation?
10. How would you drain a country house where there are no sewers?

SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

*Examiner:—W. Santo Crimp, M. Inst. C.E.*

1. Describe the principal provisions of the Public Health Acts Amendment Act, 1890.
   (*a*) Part II.
   (*b*) Part III.
2. What steps must a Sanitary Authority take before constructing sewage or sewerage works outside their district?
3. Local Authorities may, under Section 62, require houses to be supplied with water; state the conditions, and the duties of the Surveyor.
4. Give a general list of "nuisances," as detailed in Section 91, and state generally the steps that may be taken by a Sanitary Authority for remedying them.
5. Give the headings, and a brief statement of the matters with regard to which an Urban Sanitary Authority may make bye-laws under Section 157, relating to new buildings.
5. May trees be planted in public roads by an Urban Authority?
7. Under what condition may cellar dwellings be occupied?

**Nine candidates presented themselves for examination, of whom the following eight satisfied the Examiners, and were granted their certificates:—**

| | |
|---|---|
| Allen, S. (Manchester). | Graves, M. D. (York). |
| Ball, B. (Middleton). | Hurd, H. (Stratford, E). |
| Cooper, W. (Cheetham). | Saise, A. J. (Stapleton). |
| Dixon, J. R. (Carlisle). | Yarwood, Hy. (Rochdale). |

# BOARD OF EXAMINERS.

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Borough Engineer, West Ham (Past President).

H. P. Boulnois, M. Inst. C.E., City Engineer, Liverpool (Past President).

W. Santo Crimp, M. Inst. C.E., F.G.S., M.S.I., District Engineer, London County Council.

E. B. Ellice-Clark, M. Inst. C.E., late County Surveyor, West Sussex (Past President).

A. M. Fowler, M. Inst. C.E., late Borough Surveyor, Stockport.

T. Hewson, M. Inst. C.E., Borough Engineer, Leeds (Vice-President).

C. Jones, Assoc. M. Inst. C.E., Surveyor to the Local Board, Ealing (Past President).

W. G. Laws, M. Inst. C.E., City Engineer, Newcastle-on-Tyne (Past President).

James Lemon, M. Inst. C.E., F.R.I.B.A., Consulting Engineer, Southampton (Past President).

Jos. Lobley, M. Inst. C.E., Borough Engineer, Hanley (Past President).

T. De C. Meade, M. Inst. C.E., Surveyor to the Local Board, Hornsey (President).

E. Pritchard, M. Inst. C.E., 37, Waterloo Street, Birmingham (Past President).

## CANDIDATES WHO HAVE PASSED THE EXAMINATION.

| Date of Certificate. | | |
|---|---|---|
| May 7, 1887 | .. | Adcock, C. (Liverpool). |
| May 2, 1891 | .. | Allens (Radcliffe). |
| May 1, 1886 | .. | Angell, J. A. (Leytonstone). |
| May 1, 1886 | .. | Ashmead, H. (Clifton). |
| Oct. 19, 1889 | .. | Aspinall, M. (Cardiff). |
| May 2, 1891 | .. | Ball, B. (Middleton). |
| Oct. 18, 1890 | .. | Ball, C. F. (Croydon). |
| Oct. 16, 1886 | .. | Ball, G. (Scarborough). |
| May 12, 1888 | .. | Barnes, S. W. J. (Ealing). |
| May 12, 1888 | .. | Bayley, G. H. (Salford). |
| Oct. 16, 1886 | .. | Beard, E. T. (Lincoln). |
| May 12, 1888 | .. | Beynon, J. C. S. (Exeter). |
| Apr. 13, 1889 | .. | Blizard, J. H. (Southampton). |
| Apr. 13, 1889 | .. | Bradley, J. W. (Burnley). |
| Nov. 17, 1888 | .. | Brown, R. R. (Bridlington Quay). |
| Oct. 16, 1886 | .. | Brownridge, C. (Leeds). |
| May 12, 1888 | .. | Bryans, J. G. (Sunderland). |
| Nov. 17, 1888 | .. | Bryning, W. G. (Liverpool). |
| Oct. 19, 1889 | .. | Bucknall, Hy. (Stratford-on-Avon). |
| Apr. 13, 1889 | .. | Carter, G. F. (Leeds). |
| May 3, 1890 | .. | Catchpole, J. H. (Hendon). |
| May 1, 1886 | .. | Coales, H. G. (King's Lynn). |
| Oct. 22, 1887 | .. | Cook, J. (Bury). |
| May 12, 1888 | .. | Cooper, C. H. (Wimbledon). |
| May 7, 1887 | .. | Cooper, F. E. (Liverpool). |
| May 2, 1891 | .. | Cooper, W. (Cheetham). |
| May 12, 1888 | .. | Crow, A. (Stratford, E.). |
| Oct. 16, 1886 | .. | Crowther, J. A. (Leeds). |
| May 7, 1887 | .. | Dearden, Hy. (Leeds). |
| May 2, 1891 | .. | Dixon, J. R. (Carlisle). |
| Apr. 13, 1889 | .. | Dixon, W. B. (Wolverhampton). |

| Date of Certificate. | | |
|---|---|---|
| Oct, 18, 1890 | .. | Dyack, W. (Aberdeen). |
| Oct. 18, 1890 | .. | Edge, F. J. (Barrow-in-Furness). |
| May 1, 1886 | .. | Fenton, W. C. (Sheffield). |
| Nov. 17, 1888 | .. | Field, W. C. (Eastbourne). |
| May 12, 1888 | .. | Finch, A. R. (Finchley). |
| May 7, 1887 | .. | Franks, T. W. (West Bromwich). |
| Oct. 19, 1889 | .. | Gaffney, F. S. B. (Athleague). |
| May 3, 1890 | .. | Gibbs, L. (Walsall). |
| May 12, 1888 | .. | Glass, S. N. (Hackney). |
| May 12, 1888 | .. | Gloyne, R. M. (Manchester). |
| May 2, 1891 | .. | Graves, M. D. (York). |
| May 1, 1886 | .. | Greatorex, A. D. (Toxteth Park). |
| Oct. 18, 1890 | .. | Hall, W. (Ealing, W.). |
| Nov. 17, 1888 | .. | Hawkins, I. T. (Chichester). |
| May 12, 1888 | .. | Houghton, J. (King's Heath). |
| May 2, 1891 | .. | Hurd, H. (Bath). |
| Oct. 16, 1886 | .. | Jameson, M. W. (Leeds). |
| May 12, 1888 | .. | Lynam, G. T. (Barnsley). |
| Oct. 16, 1886 | .. | Mallinson, T. (Selby). |
| Oct. 18, 1890 | .. | Manley, J. (Liskeard). |
| Oct. 22, 1887 | .. | Mellor, T. E. W. (Stockton). |
| Oct. 22, 1887 | .. | Metcalf, J. W. (York). |
| May 3, 1890 | .. | Miller, J. E. (Durham). |
| Nov. 17, 1888 | .. | Millington, J. S. (Wavertree). |
| May 12, 1888 | .. | Milnes, G. P. (Wakefield). |
| Apr. 13, 1889 | .. | Nettleton, H. (Leeds). |
| May 7, 1887 | .. | Nichols, A. E. (Leeds). |
| May, 7, 1887 | .. | Nickols, F. J. (Leeds). |
| Oct. 19, 1889 | .. | Noakes, H. S. (Tunbridge Wells). |
| May 1, 1886 | .. | Osborne, F. (Dover). |
| Oct. 22, 1887 | .. | Parker, W. (Hereford). |
| Oct. 16, 1886 | .. | Pickering, J. S. (West Bromwich). |
| Oct. 19, 1889 | .. | Preston, T. (Bradford). |
| May 12, 1888 | .. | Pritchard, T. (Richmond). |
| May 7, 1887 | .. | Rich, E. W. (Hounslow). |
| May 2, 1891 | .. | Saise, A. J. (Stapleton). |
| May 1, 1886 | .. | Saunders, E. E. (Walthamstow). |
| May 7, 1887 | .. | Saunders, Jas. (Newark). |
| Oct. 22, 1887 | .. | Saville, R. W. S. (Accrington). |

| Date of Certificate. | | |
|---|---|---|
| Oct. 16, 1886 | .. | Silcock, E. J. (Leeds). |
| Apr. 13, 1889 | .. | Stringfellow, W. (Cheltenham). |
| Oct. 18, 1890 | .. | Sumner, F. (Kilburn). |
| Oct. 16, 1886 | .. | Sykes, E. (Reddish). |
| Apr. 13, 1889 | .. | Taylor, W. J. (Southampton). |
| Oct. 16, 1886 | .. | Thomas, R. J. (Carnarvon). |
| Oct. 19, 1889 | .. | Thomas, T. (Neath). |
| Apr. 13, 1889 | .. | Tomes, G. B. (Eastbourne). |
| Oct. 16, 1886 | .. | Turner, V. H. (Leeds). |
| May 7, 1887 | .. | Verschoyle, B. (Liverpool). |
| Oct. 22, 1888 | .. | Ward, F. D. (Manchester. |
| May 12, 1888 | .. | Wilson, C. L. W. (Bacup). |
| Nov. 17, 1888 | .. | Wilson, J. B. (Cockermouth). |
| May 1, 1886 | .. | Witts, J. W. (Skelton). |
| May 3, 1890 | .. | Wood, J. W. (Rochdale). |
| May 2, 1891 | .. | Yarwood, Hy. (Rochdale). |
| Oct. 16, 1886 | .. | Young, W. (Pendleton). |

# Memoirs of Deceased Members.

The Council, having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

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ROBERT HODGE, late Borough Surveyor of Plymouth, was born at Cardross, in the county of Dumbarton, Scotland, on the 23rd of January, 1810.

Early in life he removed to Glasgow, and received the principal part of his engineering education in the office of Mr. Andrew Thomson, and acted as his head assistant from 1834 to 1838. In the latter part of 1838 he was induced to come into Devonshire, and engaged in surveying different parishes in the North of Devon and Cornwall for the Tithe Commissioners. As a proof of his accuracy as a surveyor, the Commissioners, after checking the survey of the parish of Bodmin in Cornwall, generally returned the deposits made for the purpose of defraying the costs of checking the after surveys.

He occasionally returned to Scotland, and was engaged, under the direction of several well-known engineers of the day, on water-works or railways. Under Mr. Robert Thom he prepared plans and estimates for a better supply of water to the city of Glasgow at high pressure, and he was actively employed in superintending the construction of extensive basins and railways connected with the Monkland Canal.

In 1841 and 1842 he superintended the erection of the tall chimney attached to the St. Rollox Chemical Works at Glasgow. He was employed on railway work under Messrs. Grainger and Miller, and he would frequently remark as to his having been engaged as a Resident Engineer on the first locomotive line in Scotland.

After the completion of the Scotch engagements he returned to

Cornwall and Devonshire, subsequently settling at Plymouth, and from 1843 to 1854 had a large share in the railway work which at that period occupied the attention of capitalists and schemers, notably Plymouth and North Cornwall Railway, Cornwall and Devon Central Railway, Delabole and Rock Railway, this latter being conceived for the easier removal of slate from these renowned quarries to the coast, but not yet effected nor probably ever will be, seeing that a later formed company of the present day, named the Devon and Cornwall Railway, backed up by the London and South-Western Company, have nearly completed a railway near to it, by which goods may be shipped at Padstow or distributed eastwards by rail.

For nine years previous to 1854 he was chief assistant to Mr. A. H. Bampton (deceased), M. Inst. C.E., who was the second surveyor of the Borough of Plymouth under the Local Improvement Acts and Public Health Act 1848, from 1849 to 1854, and who resigned in the later year owing to unwillingness to give up private practice. As railway work was falling slack at that period, Robert Hodge made application, with others, for the vacant post, and was successful in obtaining it by four votes above those recorded for Mr. now Sir Charles A. Hartley.

From his appointment in November 1854, down to the end of 1878, he was actively engaged in carrying out the duties required by the Local Board in street improvements and radically re-modelling the entire sewerage of the Borough, at a cost of not less than 32,000*l.*, at the same time controlling and improving the works of the water supply, and managing the corporate estates which are of considerable value.

For a few months previous to his decease he suffered from asthma, which towards the last became more troublesome, and on the 7th of June, 1890, passed peacefully and painlessly away. Mr. Hodge was one of the earliest members of the Association.

The Council also regret to have to record the death of Sir Joseph William Bazalgette, C.B., Honorary Member, who was born March 1819, and died 15th March, 1891.

The remaining death is that of Mr. William Wilson, the Surveyor to the Local Board of Dalton-in-Furness, who died on 1st June, 1891. Mr. Wilson joined the Association in 1879.

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# PROCEEDINGS

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# THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

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